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EC common agricultural policy and the world trade in feed grain: A multi-region nonspatial price equilibrium analysis

by

Aniss Bahreinian

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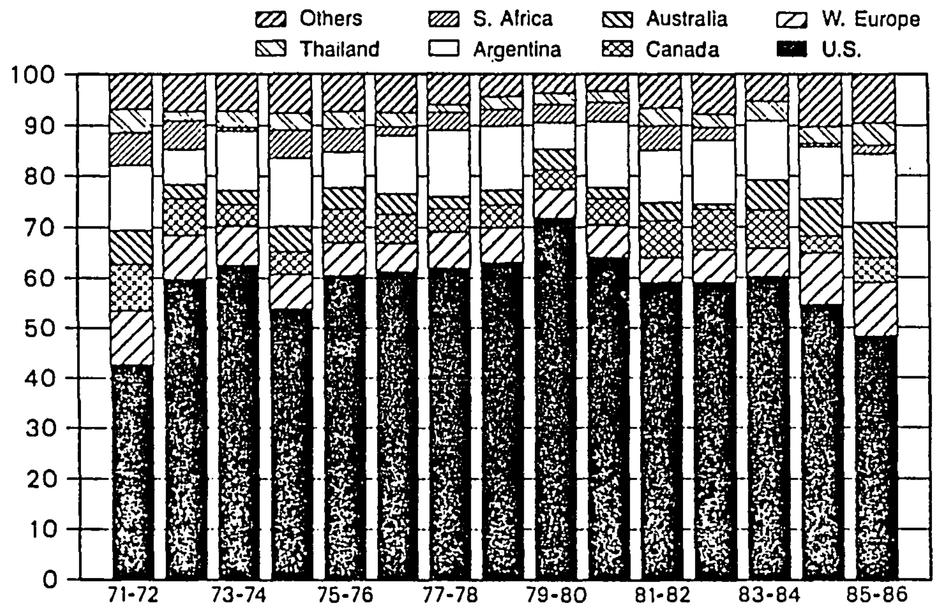
CHAPTER I. INTRODUCTION

The Problem

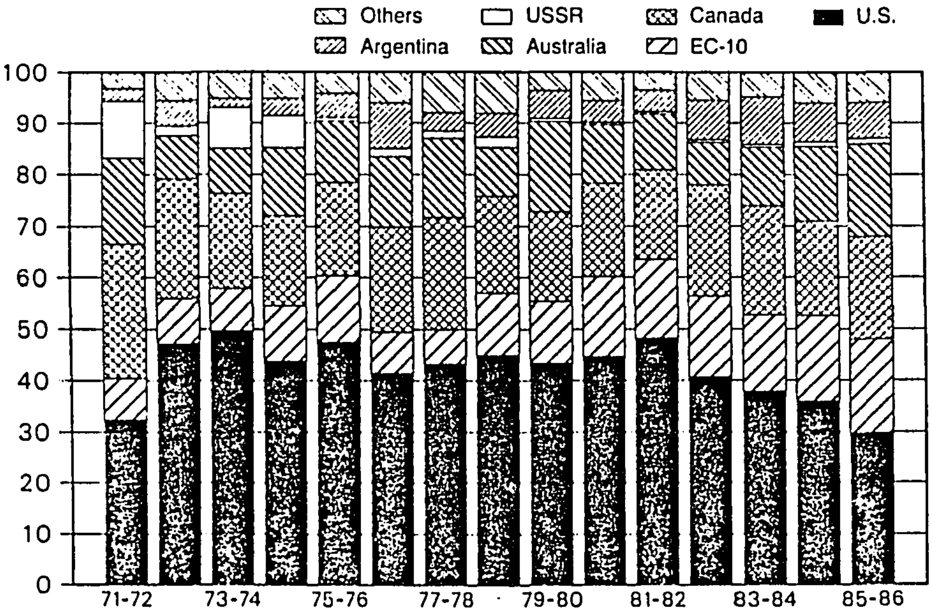
Within the so-called "free world," the most protected borders, with respect to the importation of agricultural products, particularly cereals, are those of the European Community (EC). Having adopted high insulating policy prices, the EC has turned into a net exporter of cereals, due to the surge in production and productivity, over and above what the natural domestic market conditions could bear.

The creation of surpluses and the decision to dispose of them in the world market using export subsidies have triggered heavy attacks by traditional exporters, led by the United States, on the EC policies. Criticisms revolve around the effect of EC Common Agricultural Policies (CAP) on agricultural productivity within the EC, the resulting reduction in the level and stability of world prices, and the decline in the export share of traditional exporters (Figures 1.1 and 1.2). The protected sector discussed most is the cereals sector. On the other hand, as Oleson notices: "U.S. budgetary outlays in the agricultural sector have been of such a magnitude that EEC officials have focused on U.S. policies in defense of their own." Therefore, the EC can argue that other trading countries have their own protective agricultural policies, and those protective domestic policies could have the same effect as the EC protective trade policies. While both arguments are valid to some degree, the issue is not the protection, per se, but rather the degree to which a market is protected.



Source: U.S. Department of Agriculture, Foreign Agricultural Service, *Foreign Agriculture Circular, Grains*, FG 5-86 (Washington, D.C.), May 1986 and various other issues. Marketing year data were accumulated on a July-June basis from 1970-71 through 1978-79. The USDA switched to an October-September fiscal year starting in 1979-80.

Figure 1.1. Percentage share of world coarse grain exports by major exporters (World Food Institute, 1986)



Source: U S Department of Agriculture. Foreign Agricultural Service. *Foreign Agriculture Circular, Grains*, FG 5-86 (Washington, D C.). May 1986 and various other issues

Figure 1.2. Percentage shares of world wheat trade by major exporters (World Food Institute, 1986)

These confrontations have been accompanied with some rounds of bilateral negotiations, too. But political problems and the lack of understanding, on the part of both sides, particularly the EC and the U.S. about the political forces involved in the policy making of the other side, have caused the fruitlessness of negotiations, intended to settle the controversy. As Petit (1985) puts it: "One already has the impression of a dialogue between the deaf. Actually, this can be understood if one remembers that each followed the logic of its own policy-making dynamics." What may generally be left unnoticed, in their exchange of words, is the possible effect of EC agricultural policies on the other importing or less developed countries. However, Frans Andriessen (1986), vice-president of the European Commission, in an address to the COCERAL Congress, notices that: "the only effect (of trade war) has been (in 1985/86 marketing year) an overall drop in world market prices, less return for producers, extra expenditure, and a nice profit for the U.S.S.R. While producers in the U.S. and the community may have been shielded -- at taxpayers' expense -- through deficiency payments and interventions, producers elsewhere had to face a considerable drop in prices and income."

In addition to the external pressures on the EC, the internal factors are the more urgent pressing forces in the direction of an effective reform. Among these factors are the diversity of national preferences and the increasing budget pressure. Some reform has been taking place. However, what remains controversial is the speed and the extent to which this reform should reach. The U.S. wants a quick dismantling of the CAP variable levy system, for the sake of its own agricultural and political interests. On the other hand, for the same reasons, the EC is hardly able to do so. Therefore, an overnight liberalization does not seem to be a realistic policy option, although several researchers have examined this alternative (U. Koester, 1982; P. L. Paarlberg and J. A. Sharples, 1984). Moreover, the above scenario is hard to examine on theoretical grounds, as well, since the price elasticities and market structure may be sharply in contrast, in a protective and in a liberated market. This point is further discussed in Bahreinian and Meyers (1986).

This study focuses on the EC feed grain and wheat sector, since it is the major scene of confrontations. Although other protected agricultural markets, particularly the livestock market, have a direct simultaneous relation with the feed grain sector, but due to the already large size of the model and limitations of resources, other sectors were not included.

It is intended here to assess the impact of alternative policy options, for the European feed grain and wehat sector, that are more favored by European consumers and producers on the quantity of the net trade of each of the trading countries on the world feed grain market and the world price level. In other words, the following questions are to be answered: What are the determinants of policy prices in the EC? How does a change in the EC price level affect the world feed grain market participants, in terms of price and the quantity of trade? What those effects would be in the case of replacing the present price system with free entry for imported grain, together with a producer subsidy for grain producers? What would be the impact of reducing the protection rate in the grain sector and instead raising the protection rate for the feed grain substitutes, specifically soybeans and its products?

In order to evaluate the above impacts, first the existing literature, relevant to this study, is reviewed. Then, in Chapter II the market structure of each relevant market participant has been studied. The next chapter explores the conceptual framework of the feed grain model. Then, the empirical results of estimation and simulation are presented in Chapter IV. The next chapter is a discussion of the impact of each policy alternative. Chapter V concludes the study with the summary and conclusions.

Review of Literature

Policy prices play a key role in this study. It is important to include the simultaneous relationship between the policy and other important variables, determined in the model. Therefore, there should be a clear understanding of the determinants of price policy, before trying to evaluate its impact on world trade. The relevant literature, then, not only includes those examining the impact of EC policies on the U.S. and others trading in the feed grain market, but also those analyzing policy price determination process. Before proceeding with this section, it is recommended to review the EC market and policies presented in the next chapter.

The literature related to EC and relevant to this study could be divided into three categories: analyses of EC market structures and decision making processes, analyses focusing on the effect of the EC on U.S. trade, and analyses of the EC in the context of the world market in relation to other major traders.

Among those focusing on the working of the EC commodity market and the policy making process, there seems to be controversy on the nature of price determination. Rastegari (1982), using data from 1962-1979 for the community of six, argues that policy prices in the EC are being determined by a number of variables, including the prices of substitutes, final output of feed grain such as livestock, farm income, and world prices in the world market. Simultaneously, world prices are determined by the EC policy prices along with price and income levels in the rest of the world.

Josling (1980), on the other hand, believes that inflation and exchange rates are directly considered in policy price decisions for agricultural commodities in the EC, putting an upper and lower bound on them. These policy prices, together with the consumption and production level in the EC, would then determine the expenditure of the guarantee section on CAP.

In the period covered by Rastegari study, since surplus problems in the feed grain sector were nonexistent, world prices could not have produced a binding constraint for the CAP. The Josling analysis sounds more realistic over that period. But in a period of surplus production like the present, budget pressure as a direct explanatory variable and the world price level as an indirect explanatory variable should not be left out of the analysis.

Von Witzke (1986), turning back to the objectives of the EC, studies the period 1976-1981. He argues that those objectives (see page 22) reduce the problem to one of policy prices being determined by real per capita value added in agriculture, and the growth in the guarantee section (see page 25) expenditure compared to the growth in total EC budget expenditure. Comparing the results of the regressions for the policy prices in ECU and in national currencies, he concludes the MCAs (see page 28) are a significant factor in price determination and, therefore, prices in national currencies are the relevant variables to be studied. While Von Witzke tries to approach the policy determination problem theoretically, he is deemphasizing the role of exchange rates and world prices by treating these variables implicitly.

Meilke and de Gorter (1985) examine the political economy of policy price determination. They argue that policy prices are a product of politicians' attempts to maximize the political support of two groups, namely producers and consumers/taxpayers. Therefore, they distinguish between intervention prices as producer support prices, and threshold prices as proxies of consumer prices. In the final reduced form, then, intervention prices are a function of world prices, per capita consumption expenditure and threshold prices. Variables are in real terms and represent the growth rates over the 1968-1983 period. What should be noted about this study is that since policy prices in the EC are directly calculated from each other, it should be no surprise that a high percentage of variation in one policy price is explained by the variations in the other policy price. However, the effort to incorporate political economy in modeling the policy determination process should be greatly appreciated, and considered a step forward.

The same authors, in another study, hypothesize the reverse relation, i.e., the threshold price is considered as a function of intervention price, world price, net imports, and the lagged threshold price. The intervention price is not considered to have a relation with the threshold price, but rather with net imports, an index of green rate changes, the CPI, and the world price level. In the same model, they try to formulate the wheat sector in the EC and examine the response of the EC-wheat sector to different policies and hypothetical situations such as: 1) an exogenous shock in the intervention price, 2) an exogenous shock in the threshold price, 3) a devaluation of the U.S. dollar, relative to the ECU, and 4) a relative decline in the excess demand for EC wheat. At the end, they arrive at the following conclusions:

-- The strength of the U.S. dollar since 1980 has minimized the cost of subsidies to the EC.

-- The green rate of exchange has as much effect as policy prices have on member country farm prices.

-- Since the introduction of the silo system (see page 22), intervention prices have little impact on the area planted to wheat.

-- The threshold prices for wheat have been at a lower level than what would have been optimal to minimize budget costs.

The model seems to be incomplete because, although they recognize the problem of "uncommon prices" by introducing separate equations to determine national price levels, these prices are not related to any national or EC level production-consumption behavior. Therefore, the model only determines the national prices but does not incorporate them in the determination of market behavior. Another factor ignored in their model is the role that policy prices play in the productivity of EC agriculture. There is no direct relation between prices and productivity in this model.

The second group of literature focuses more on U.S.-EC trade. Paarlberg and Sharples (1984) analyze the costs EC agricultural policies have on U.S. agriculture. He uses a simple model, including demand and supply as a function of own price only, with trade as a residual. He concludes that the complete liberalization of EC trade would raise world prices by four percent, U.S. agricultural trade by 2 billion dollars, and other exporters' agricultural trade by 600 million dollars. The increase in world prices would reduce import expenditures by the importing countries, on coarse grains, wheat, soybeans and soymeal, by 300 million dollars. The distributional effect for the U.S. is a transfer of income from consumers to producers and from soybean producers to grain growers. The model used in the above study is too simplistic, and apparently the author did not intend to build a more elaborate model, either.

Petit (1985) studies the consequences of the EC-U.S. confrontation in agricultural export markets in a political economic framework. After reviewing several works in this area, he firmly concludes that: "If the

CAP was less protectionist, the first gainers would be developed country exporters, and a distant second, some developing countries. In Europe, consumers would be better off and producers significantly worse off. In some poor developing countries importing cereals, consumers would be adversely affected. In addition, it is likely that less food aid would be available." While the strength of this study is in its emphasis on the often neglected area of the interrelationship between politics and the policy making process, the nonquantitative nature of it does not produce a clear-cut answer as to "whether or not added price induced variations in consumption and in international trade ... would cumulate with the present variations in the volume of the trade, resulting from current European price stabilization policies."

Meyers et al. (1985) do a comparative analysis, comparing the impact of three factors, most cited in the literature, which are believed to be responsible for shrinking U.S. agricultural exports. They fix the exchange rate, income growth rate, and the threshold prices, one at a time, at their 1978/79 level, in the context of three separate multi-regional world market models for soybeans, wheat, and coarse grains. They then report that the higher threshold price has reduced the value of U.S. exports (1983-85 average) by 5.2 percent, whereas the combined effect of lower income growth and the higher value of the dollar has been a reduction of 25.8 percent in the value of U.S. exports in those commodities.

It now seems appropriate to turn the focus on the literature that analyzes the effect of EC protective policies on all of its trading partners. Valdez and Zietz (1980) have done one of the earliest quantitative studies on this issue. He looks at the effect of OECD countries' protective agricultural policies on less developed countries (LDC), utilizing a set of presumed supply-demand relationships within and between different commodity groups. Several LDC and OECD countries have been included in the study. He finds that the gain in LDCs' exports varies across different commodity groups. A 50 percent reduction in trade barriers in OECD countries would raise total world exports by 8.5 billion dollars. This implies only a 12 percent change in coarse grain export of LDCs. Trade liberalization would raise world exports by 8 billion dollars, of which 1.0 billion dollars is the increase in value of coarse grain exports. The share of the LDC countries in the total increment is 13 percent, compared to 83 percent for the OECD countries. These findings are the projections for 1977, based on 1975-1977 data. The protection rate estimates were taken from other studies.

Koester (1982), using the Valdez study, emphasizes the effect of the CAP grain policies on developing countries, with which the EC has had increased trade relations, since the establishment of the community. He examines the impact of alternative agricultural policies of the EC on the developing countries. The first scenario is the continuation of current policies in which the EC would continue to cover, by its surplus, the grain deficit of developing countries predicted to be increased by 1990. In the second scenario, the removal of EC grain import barriers would raise world market prices by 19.7, 14.3, and 2.2 percent for oats, barley, and maize, respectively. This would result in an increase in the import volume of oats by 15.3 percent and of barley by 59.7 percent. Grain imports of developed countries would fall by one million and those of developing countries by 6.8 million metric tons, or by 19.8 percent. Liberalizing the grain market, then, is taken to imply livestock market deregulation, and that creates a new import market for some developing counties. At the same time, however, the increased competitiveness of grain (through the change in the price ratio) would wipe out a good portion of the grain substitute markets, such as maize and soybeans, in which developing countries play an important role. The reduction in soymeal demand would cause a decline in supply and a rise in the price of vegetable oil, which is one of the major imports of some developing countries. In the third scenario, it is argued that protection per se may not be the source of instability in the world price, but rather the complete disorientation between the grain price ratios prevailing in the EC market and those of the world market is viewed to have a significant role. To evaluate this hypothesis, the study allows for the fluctuation of the protected price ratios in response to the world market. This would result in a welfare gain for the EC and help to stabilize world market prices for individual grains.

Mahama (1985) studies the impact of price insulation policies on world wheat market stability. She constructs a model for several regions, including the EC, over the 1967-1980 period. After comparing the simulation of EC free trade with a basic protective scenario, she finds that the protective policies of the EC have contributed only 2.4

percent of the instability and 13 percent of the decline in the world wheat price.

Tyers (1985) uses a multi-market, multi-regional model. He studies the effect of EC liberalization of trade, in the grain and livestock sector, on the EC itself and on the world market. Although one of the major objectives of his model is to capture the cross commodity effects of trade liberalization, one cannot have complete success in meeting that objective without taking into account the importance of nongrain substitutes in these markets. The model has three specific advantages compared to the previous model in this area, i.e., multi-market structure, endogenous trade policy behavior, and endogenous stock holding behavior.

A total liberalization of the EC grain and livestock section in 1980 would bring about an increase of 16 percent in the level and a decline of 24 percent in the instability of world coarse grain prices. Consequently, world trade in coarse grain would rise by 23.2 million tons. However, world welfare, including the EC itself, would decline by 1.41 billion dollars. The decline in the welfare is due to a net loss of welfare of 4.3 billion dollars in Japan and the LDCs, a gain of 1.9 billion dollars for the United States, and a gain of 0.72 billion dollars for Australia and Canada combined.

In another scenario, a graduated partial EC liberalization takes place with a two percent reduction in policy prices, starting in 1980, and a 25 percent reduction in the elasticity of production. By 1990, the impact of this policy on the world market is to raise world prices of coarse grains by 5.31 percent and world trade in coarse grains by 7.1 million tons. The welfare impact is a net reduction of 3.4 billion dollars in world welfare (including the EC), where the big losers are Japan and the

LDCs (-4 billion dollars), while the developed country importers' gain in welfare is about 0.6 billion dollars.

One general concern that is outstanding throughout the literature reviewed is the state of the world market when and if the EC removes all external and internal trade barriers. This alternative, although attractive, is not a realistic one since the political clout of European farmers, above all other economic and noneconomic reasons, would not allow it to happen overnight. Another criticism of the overnight trade liberalization scenario reviewed in the literature is that they assume the protective structure stays unchanged. This may be true the day after, but the protective structure is certainly going to change shortly after the announcement of trade liberalization. Therefore, particularly those studies that use the protective structure to make long or medium term projections under the free trade scenarios, contain significant errors. It could be argued that it would be impossible to arrive at an estimation of a free trade market in the presence of the data on protective structure. What could be done is at least to project the direction of the change in the elasticity of production and consumption and do a sensitivity analysis under different elasticities. This is what is done in Tyers (1985), however, he only looks at a one-shot change in the elasticity of production.

Another criticism common to the literature on the EC is that most studies neglect the effect of prices on the productivity of EC agriculture. This is an important behavioral relationship in the EC agriculture, as is discussed in Chapter II, and is one of the points of controversy in the U.S.-EC negotiations.

What is intended in the present study is to examine the more realistic alternatives that have been overlooked in the previous literature. These alternatives include: gradual liberalization, feed grain and feed grain substitute protection trade-offs, and the introduction of producer subsidy.

CHAPTER II. THE INTERNATIONAL FEED GRAIN MARKET

Capturing the important variables and relationships in a model that could represent the world market requires an analysis of the production and consumption situation, including the prevailing institutional market interventions, in each of the regions participating in trade over the period of concern. That is a major task, for there are many participants in the world feed grain market. Therefore, only those regions that are perceived to have an important role in the international market are analyzed in this study, and the rest of the regions are summed together as the Rest of the World (ROW). The term region is used here to represent the cases in which more than one country has been aggregated together as one region.

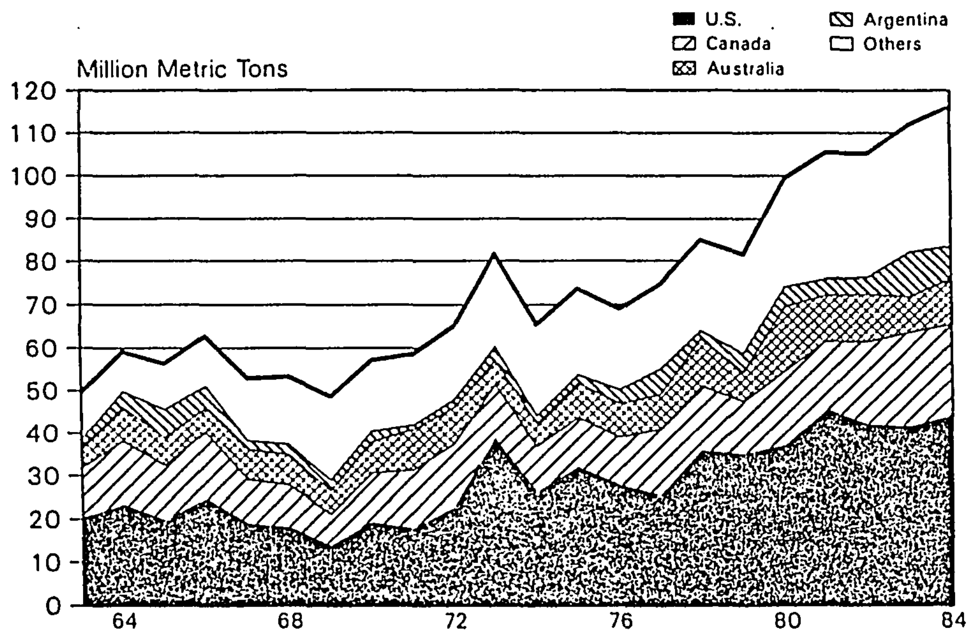
Historically, the demand for feed grain originates in developed countries such as: the U.S., EC, Canada, Soviet Union, etc. The economic expansion of the 1970s, a period covered in this study, promoted meat consumption and consequently raised feed use. Technological progress in processing and innovations in the nonfeed usage of feed grains, like in the production of gasohol and sweeteners, has created a new source of demand in the regions, where technology is available, and where government policies, such as protection of the domestic sugar industry, have paved the way for growth in the nonfeed usage of feed grains. Furthermore, the developments in the oil market affected another set of customers in the world meat and feed grain market. The oil importing countries effectively entered the market, after the oil price boom. The third group that entered the market as a relevant importer is the developing countries that have become increasingly linked with the developed economies, such as high income countries in East Asia.

On the supply side, the developed countries, such as the U.S., Canada, and Australia, have been traditionally the major suppliers in the world feed grain market (Figures 2.1 and 2.2). The prospect for expansion in demand, however, attracted developing countries, such as Thailand, into the world market. This, in turn, has raised capital investment in the agricultural sector of developing countries. Developments in the centrally planned economies transformed the Soviet Union from a major exporting region to an important importing region in the early 1970s. The latest developments in China have turned that country into an exporter with growth potential.

The regions included in this study, as identified in Appendix A, are each composed of countries similar in consumption and/or production structure, an an attempt to avoid the problems associated with aggregation. Spain has been included because of both its importance as a trader in feed grain markets and because of its association with the EC in January of 1986.

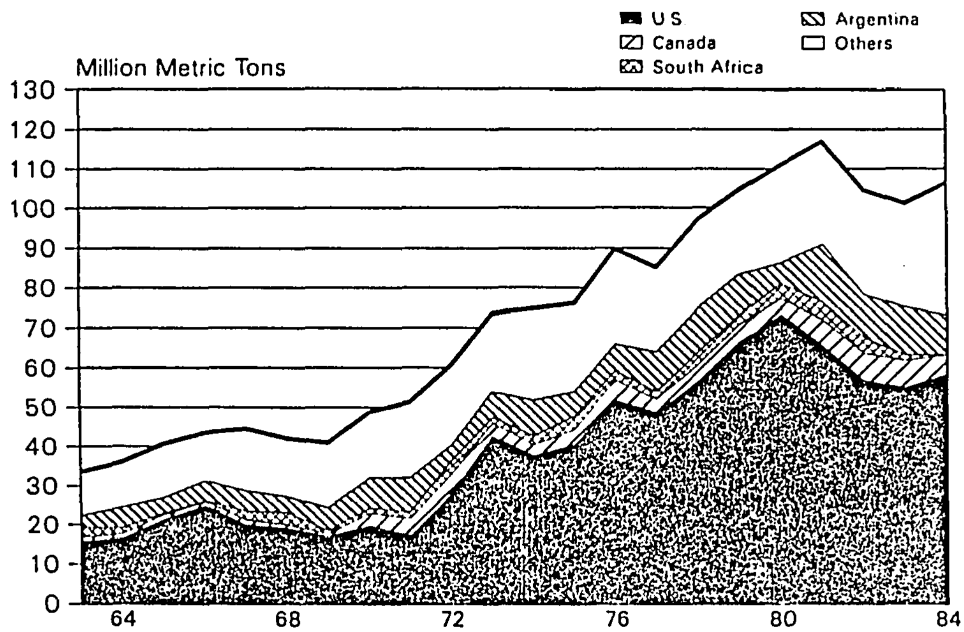
The Economic Community

After World War II, a weakened Europe needed to gain strength for both political and economic reasons. A strong Europe was desired by the United States and western Europeans to block the feared further expansion of the Soviet block. Therefore, the United States supported the



Source: Food and Agriculture Organization of the United Nations, *Trade Yearbook* (Rome, Italy), various issues.

Figure 2.1. World wheat export by country of origin (World Food Institute, 1986



Source: Food and Agriculture Organization of the United Nations. *Trade Yearbook* (Rome, Italy), various issues.

Figure 2.2. World coarse grain exports by country of origin (World Food Institute, 1986)

establishment of the EEC, despite concerns about the economic disadvantages it might produce for the U.S.

The six original members (France, Germany, Italy, Belgium, Luxemburg, and the Netherlands) established the European Economic Community (EEC) in 1959, following the Rome Treaty. The formation of the EEC essentially created a common border for the region, confronting the nonmember countries, and removed the barriers to trade among the member countries, i.e., free trade of industrial commodities inside the common border and free movement of labor.

Climatic conditions favor the production of grain and European grain farmers have a rather strong voice in politics. Diversity in the structure of production and in the types of products produced within the community, the political clout of the European farmers, together with the post-war food shortage experience and the already protected agriculture within the member countries, resulted in the formation of a protective structure for agriculture similar to that created for industry. Further expansion in grain production, particularly at the time of establishment of the EC, required the use of expensive and extensive technology, due to land constraint and structure of the farm sector. As a result, farmers were unable to compete with imported grain and survive.

Consequently, the Common Agricultural Policy (CAP) was initiated in 1962. After going through a transition period, CAP was uniformly adopted in 1967, across the member countries. One has to bear in mind that, contrary to common belief, CAP was a continuation of an already protective system and the nature of its objectives was not new, only its organization was to unify the members countries' policies around the Common Agricultural Policy.

CAP is designed on the basis of three principles, namely, single market, community preference, and common financing. Single market is realized through the adoption of common prices and policies and, hence, removal of national boundaries within the EC. Community preferences are considered through price insulation policies granting a competitive position to the member countries. Finally, the expenditures of CAP are financed by the community resources and not by individual members. The community resources include member countries' contributions and the amount levied on imports from nonmember countries. The expenditures include, among other things, the export refund and the Monetary Compensatory Amounts (MCA) spent on internal trade.

The objectives of the CAP were stated as:

-- Raising agricultural productivity.

-- Maintaining rural standards of living at an adequate level.

-- Stabilizing markets.

-- Assuring regular supplies.

-- Maintaining reasonable prices.

These objectives have been met through price policies ranging from variable levies to export subsidies, all intended to insulate the domestic market from world prices.

The cost of production varies within the boundaries of the EC. Germany produces some of the most expensive grain in Europe, while France's comparative advantage results in the least cost of production of grain in the community. Therefore, German farmers cannot freely compete even within the boundaries of the EC. This situation resulted in the adoption of a protection level similar to pre-existing levels of protection in Germany by the whole community.

Cereals, including feed grains, were one of the first groups of agricultural commodities for which the support prices were introduced. The three major prices for grains, set directly by CAP, are:

-- The intervention price is the minimum guarantee price at which EC authorities will purchase grain from producers. The EC has established several stations throughout the EC to purchase and store grain. The base intervention price formally reported is the one offered in Ormes, France, the most grain surplus area. The price levels offered in different stations, by intervention authorities, differ according to the distance of each station from the designated grain deficit and grain surplus areas and, also, according to the time these grains are brought to the station.

-- The target price is theoretically based on the intervention price (Figure 2.3) at Dewisberg, as well as farmers' income, production and utilization of various grains within the EC, and developments in trade with nonmember countries.

-- Threshold price is equal to the target price, minus the transportation cost from Rotterdam to Dewisberg, and the importer's profit margin.

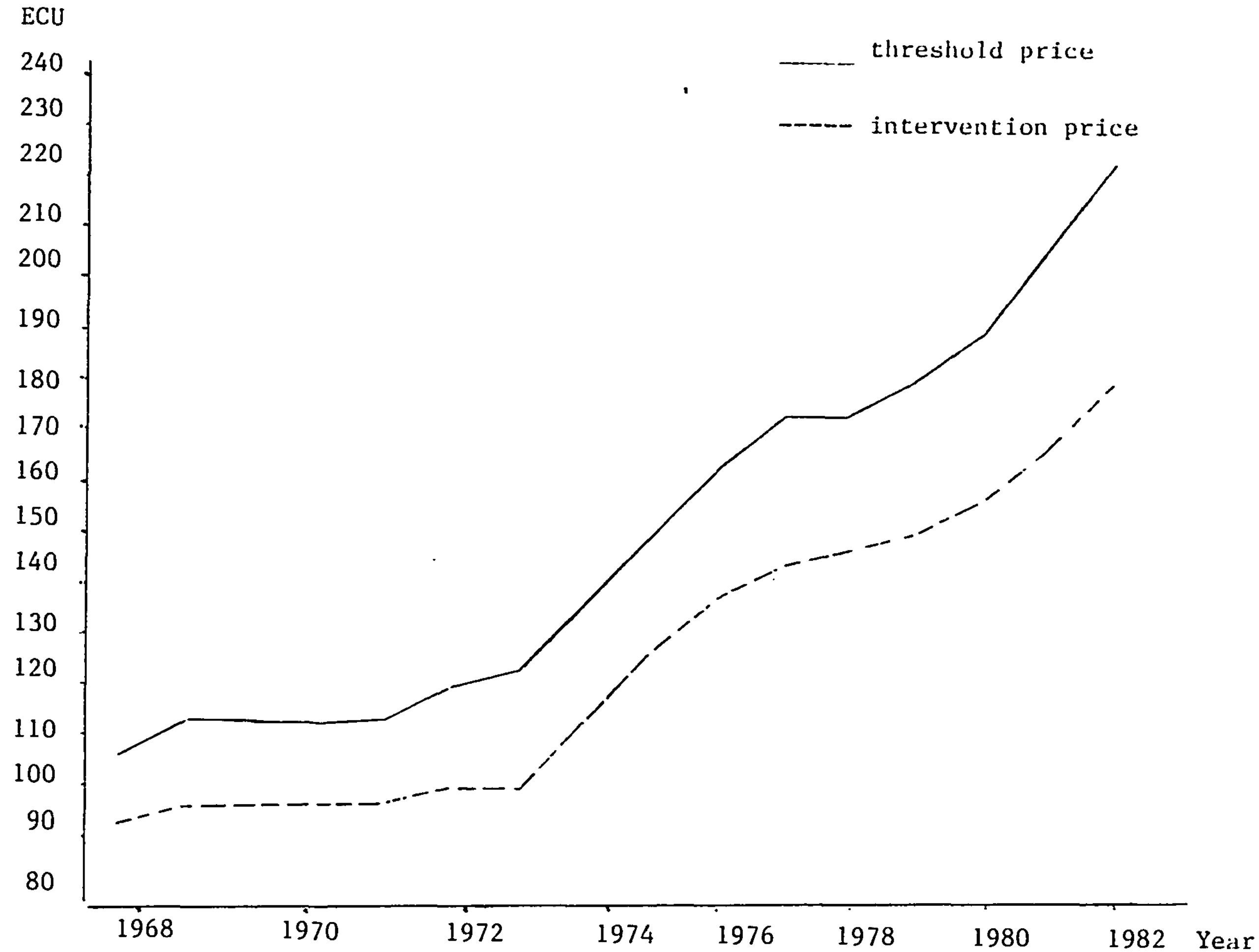


Figure 2.3. EC barley intervention and threshold price

These policy prices are announced each year prior to the planting period. They are changed monthly after harvest time in order to keep a steady flow in storage activities. They also vary according to the grade of grain. The variable levy is announced weekly, calculated by the difference between the minimum offer (cif) price for the imported grain at Rotterdam and the threshold price for the month. Figure 2.4 shows the relation between policy and world prices. The cost to the importers, then, is equal to the cif price plus the variable levy. The minimum offered cif price at Rotterdam, plus the variable levy, plus the trans-shipment cost, equals the threshold price at Rotterdam. On the other hand, the surplus grain purchased at the market price (which is between the threshold and intervention prices, on average), with the help of a subsidy in the form of an export refund, would enter the world market at the world price level.

The variable levy paid by importers becomes a source of income for the European Agricultural Guarantee and Guidance Fund (EAGGF). The intervention purchases, storage costs, and the cost of the disposition of surplus in the world market is, in part or totally, financed by the guarantee section of EAGGF. On the other hand, the exporters would purchase the grain at market price and through a tender bid system would receive the difference between the market price and the f.o.b. price of grain in Rotterdam. When the community wants to dispose of the intervention inventories in the world market, the export refund would be the difference between the intervention and the f.o.b. price. This price mechanism is illustrated in Figure 2.5.

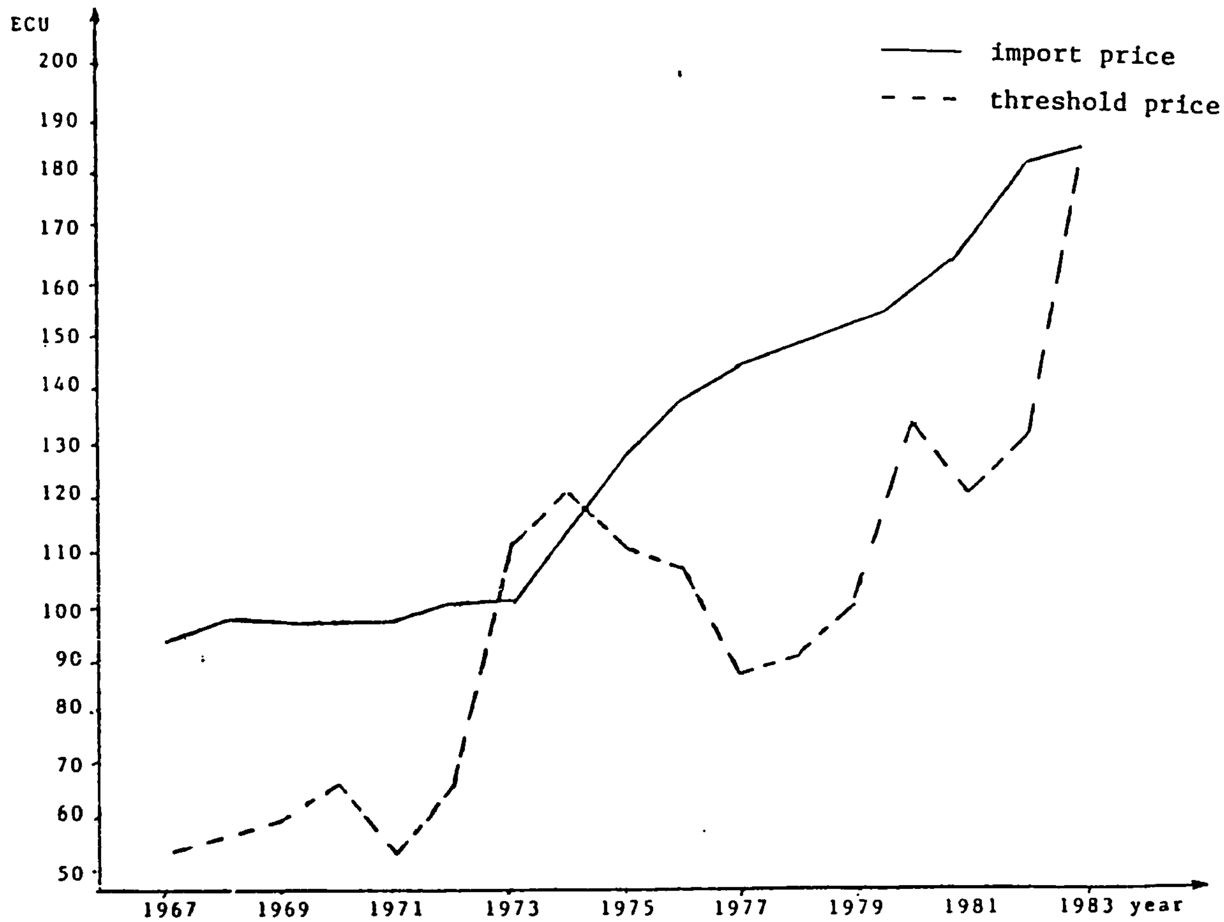


Figure 2.4. EC corn threshold and import price

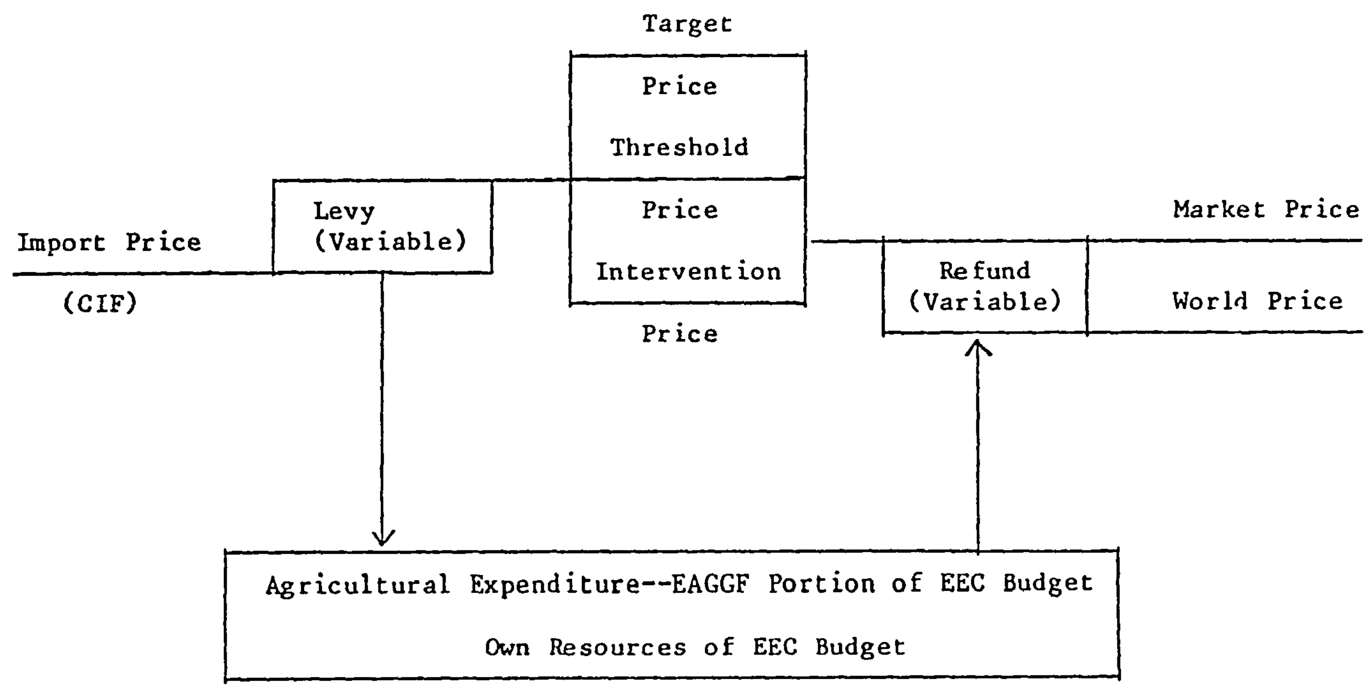


Figure 2.5. EC levy and refund system for grain

The protection scheme for wheat in the EC is even more complex in that two grades of wheat are recognized; one with a high quality, known as hard wheat, used for bread making, and one of lower quality, known as soft wheat, mostly used for feed. There are two very different policy prices attached to these different grades and there exists an intermediate price, introduced in 1978, known as the reference price. What is in surplus is soft wheat that is a substitute, both in production and consumption, for feed grains. The Silo System Policy, introduced in 1976, has equalized the intervention prices of feed grains and soft wheat. Durum, or hard wheat, on the other hand, is mainly being imported. The high policy prices and the aid to durum wheat producers have not sufficed to make the EC self-sufficient in this crop.

These policy prices are supposed to be "common" within the EC, but actually since 1969 they have become "uncommon." Developments in the exchange rates of France and Germany in 1969 resulted in the introduction of the Monetary Compensatory Amount (MCA), in order to keep the grain prices the same in the countries with devalued or revalued exchange rates. An example would make it more clear. Suppose the French franc has been devalued and the German mark has been revalued. The prices of French grain converted to German marks at the border, then, becomes lower than the German grain price. This would result in flooding the German market with the French grain. To prevent this, the community would levy an MCA on French grain entering the German market to make their prices equivalent to the level prevailing in the German market. On the other hand, Germany's import of grain from France would be subsidized by the community through the MCAs.

This fact could be used in arguing against the use of a single price for modeling the EC. Theoretically, this argument is correct although, practically speaking, these price differentials could be seen in any large region. Grain prices in different parts of the United States or Canada are not the same either. What is important, however, is that these regional prices move together (Figure 2.6).

These arguments would lead us to ask what factors determine these policy prices. While Rastegari (1982) believes that world prices and the EC policy prices have a direct simultaneous relationship with each other, history tells us that at the time of creation of CAP prices, not the world price level but the already existing protection levels were the major determinants of the initial CAP prices. In fact, these initial policy prices were a political compromise between Germany with the highest level of existing protection and France with the lowest protection rate. It could also be argued that the initial policy price, set in 1962, has also set the desired rural standard of living. Annual changes since this time have been determined by the inflation rate, and the exchange rate changes to keep the rural standard of living at an acceptable level.

As long as the EC was a net importer, budget pressure was not a factor in price determination, although self-sufficiency was a legitimate concern. Since the appearance of surplus production, exports and hence export subsidies, became a major concern, one that is gaining increasing

Figure 2.6. EC corn producer and intervention price

importance because of its impact on budget pressure. Therefore, it is assumed in this study that world prices, only indirectly through their difference with the policy price and hence through budget pressure, would affect the policy prices. The direct factors important in price policy determination, thus, are considered to be inflation, the exchange rate, and budget pressure.

To understand the structure of the production of grain in the EEC it has to be broken into different commodities and factors of production. Production has two components; area planted and yield. While developments in area only represent the changes in land, as one factor of production improvements in yield represent, along with changes in weather, the structural change in production which includes:

1) improvements in seed varieties, tillage and irrigation practices, and capital investments;
2) the use of more productive and effective fertilizers and other purchased inputs;
3) control of farms by more progressive managers; and
4) increased crop specialization by farms due to the growth in the average size of the farm.

Within the EC, different regions have adopted a variety of technological levels. Where there exists enough cultivable land to expand production, more land has been brought under cultivation, as in France. France has long been a major producer and exporter of barley. This factor, along with other factors, explains the fact that production growth in the barley sector in the EC is due to growth in allocation of more land to the production of barley.

Whenever land is considered a severe constraint, mechanical, chemical, and/or biotechnology has been intensively employed to expand production, as in Britain and Italy. Wheat and corn yields in the EC are among the highest levels attained in the world. In light of price policies, Italian producers are able to use some of the most expensive fertilizers to raise corn yields in that region. Tables A.1, A.2, and A.4 shows developments in yields and area planted to corn, wheat, and barley.

In the context of that picture, this study treats each crop with respect to its particular production and consumption structure. As can be seen in Tables A.1-A.3, corn and wheat production growth in the EC is based on yield improvements, whereas growth in barley production is due to expansion in the area planted. This study uses the fertilizer price index as a proxy for the purchased inputs, due to the actual importance of fertilizer among the purchased inputs and to the availability of the data series on that.

Barley, corn, and wheat could be considered substitutes in production and consumption in the EC. In addition to these, a soymeal-manioc combination, corn glutten feed, other oilseed meals, and citruce pellets, all of which are imported freely, are important substitutes for the grains used as feed due to high domestic policy prices of grains. Income expansion in the EC, and the consequent rise in demand for protein food, are the major factors in the growth of feed use.

The other component in feed grain demand in the EC is the part processed by industries. This portion of feed grain demand has been increasing rapidly due to technological advances and innovation. The direct use of feed grains for human consumption is not considered significant and, therefore, is included in the nonfeed demand. In the case of wheat, food use has been exogenized since the importance of wheat in this study is in its substitutability with feed grains in production and feed use.

The United States

The U.S. supplies the largest share of world import demand for feed grains, an average of about 60 percent since the mid-1970s (Table A.5). By far, the feed grain most used domestically and exported by the U.S. is corn. However, more recently, with the application of new technology to sorghum production, grain sorghum is gaining in importance among the feed grains. Corn is mainly planted in the midwestern plains, known as the corn belt, where soybeans are a major substitute in production. Sorghum is planted in some of the midwestern states, as well as some of the southern states. The major crop competing in area with sorghum is wheat. Barley is produced in the northern states and California. Wheat could be considered the major crop competing with barley in area, however, different crops compete with barley, depending on the region.

Mechanical, chemical, and biotechnological advances have been heavily applied to corn production in the U.S. Consequently, production growth in the corn sector is primarily due to significant improvements in yield. However, this level of application of high yield technology may be attributed, in part, to the acreage reduction policies pursued by the U.S. government. These policies, along with the stock management and associated price policies, have been utilized in order to maintain income for grain producers and to attain more stability in price levels faced by grain consumers. The loan rate acts as a minimum guarantee price for the producers who withhold their grain from the market through the Commodity Credit Corporation (CCC). In some years, the producer's participation in some sort of acreage reduction program is a prerequisite for his/her eligibility to receive program benefits. On the other hand, the CCC release price, at which the CCC stock could enter the market, tends to put an effective ceiling on domestic prices.

Since 1977, with the introduction of Farmer Owned Reserve (FOR) policy, the gap between loan and release prices has been widened, while giving incentives to remove the commodity from the market for a longer period (three years compared to nine months under the loan program). Another feature of the 1977 act was to adjust target prices for production costs per bushel. The accumulation of government stocks led to the Payment in Kind (PIK) program which cost the government 5.6 billion dollars in 1983. The declining export share of the U.S. in the 1980s and the resulting accumulation of stocks, coupled with the philosophical viewpoints of the present administration, were important factors contributing to the shape of the 1985 farm bill. The legislation calls for a decline in the loan rate and the adoption of a selective export PIK program in hopes of driving the competitors out and gaining a larger share of the world market.

The U.S., as the major exporter, has managed to keep the world prices more or less within the domestic floor-ceiling price range. Therefore, U.S. farm prices are considered, in this study, as an appropriate proxy for the world price level. Paarlberg and Sharples (1984) view this price setting as a major factor which makes the U.S. the residual supplier in the world market. In these circumstances, he argues, the other suppliers would set their prices just below U.S. prices so their products are sold first in the market. Importers would turn to the U.S. to round off their needs only after they have purchased the bargains offered by other exporters. Because of the argument made by Paarlberg, and because of the contribution of sizable carryover stocks to the ability of the U.S. to play the role of a residual supplier, U.S. exports are defined to be identical to the excess of the world import demand over the total supply of other exporters in the world market.

On the demand side, soymeal and wheat are considered substitutes for the feed grains in feed use. Feed use has been increasing in accordance with the growth in per capita income and population. The growth rate in feed use, while steady, is not as large as the rapid growth in food, seed, and industrial use, aggregated as nonfeed use.

Argentina

Thanks to its rich farmland, the presence of necessary structural characteristics, and marketing expertise, Argentina has long been a significant supplier in world agricultural markets (Table A.6). Wheat, corn, sunflowers, linseed, grain sorghum, and soybeans constitute 70 percent of trade in nonlivestock products (Mielke, 1984). The consumption, production, and trade of livestock in Argentina is also of significance in the world. Agricultural trade is encouraged in Argentina and produces an important source of income for the government through export taxes. However, there have been drastic shifts in these policies, depending on the government in power. Another significant factor encouraging exports is virtual absence of storage facilities. This factor further contributes to the inelasticity of Argentine exports.

The heavy taxes, inflation rate, and the relatively high prices of fertilizers have caused a backwardness in productivity and production in comparison with developed country exporters. In the feed grain market, Argentina's trade consists of sorghum and corn, making Argentina second only to the U.S. in the export market. Corn, sorghum, wheat, and soybeans could, thus, be considered as the crops competing for area. Mielke (1984) states that government policies have favored cattle production, as opposed to grain. "Producers coupled grain and oilseed production with most of the cattle operations, including supplemental winter feeding and crop and cattle ration. The mixed farm, became the predominant production unit. Feed lots, similar to those in the United States, are virtually unknown." Therefore, Argentine feed use of feed grains is considerably less than one might expect, considering the amount of livestock produced. Nevertheless, feed use is the major component of domestic feed grain consumption. The nonfeed use of feed grain, in the absence of necessary industrial structure and demand, is composed of seed and food use.

Canada

Climatic conditions in Canada favor the production of grain, not leaving many other significant choices for the producers. Wheat, barley, and oats constitute a big portion of crop production and exports of Canada (Table A.7). While wheat has traditionally been more important, oats have been declining in relevance. These crops, however, are produced in the prairie provinces of western Canada where rapeseed is the nongrain crop competing in area with grain. Eastern Canada, which is highly populated, is a grain deficit area specializing in livestock production to which feed grain is exported from western Canada and the United States. The production of corn in eastern Canada has increased as area harvested doubled and production tripled between 1966 and 1976. Soybeans is the major crop competing with corn in the eastern provinces.

The Canadian Wheat Board (CWB) was initially created to monopolize the domestic interprovincial market and the export market. The CWB guarantees a minimum payment, known as the initial price, to grain producers at the time of delivery and for what has been specified in the delivery quota for each farmer. This price is determined on the basis of anticipated market prices and a moving average of previous prices. They are announced prior to the commencement of the crop year. These initial prices, together with the market prices in the last period, are assumed in this study to be used by farmers to develop expectations about the prices to be received at harvest time.

The CWB sells the grain at a weighted average of the prices prevailing in the nonboard markets to the domestic consumers, and at a price competing with world prices, in the export market. At the end of the marketing year, the CWB deducts the operating costs and total initial payment from the pool of sales and distributes the remainder, known as final payment, to the farmers in proportion to quantity and quality of delivery. The farmers sell the remainder of their production, in excess of the delivery quota, in the off-board markets.

The significance of price differentials in eastern and western Canada resulted in the CWB relaxing the interprovincial trade restrictions in 1973. This was followed by the adoption of an interim policy, in 1974, introducing a dual marketing system that gave the grain producers three options for marketing their product, through CWB, to the Agricultural Product Board (APB), or in the off-board market. The APB price is final and is approximately the mean of the initial price and the final realized price. Therefore, under this policy, CWB acts as a monopolist only in the export market, and as a residual supplier in the domestic market. It should be noted here that corn does not fall under the regulations of CWB.

The competition set by the U.S. corn brought further reforms in the CWB pricing policies. In 1976, CWB adopted the policy of offering the feed grain, in the domestic market, at a corn competitive formula price determined on the basis of feed equivalence to U.S. corn. It acts as a ceiling but there is no system to protect producers against low prices in case they choose to offer their product to nonboard markets.

While corn and barley in Canada have two separate production structures, in consumption they could be used together and substituted.

Therefore, the aggregate consumption of barley and corn is of concern to this study, where soymeal could be considered a major substitute for this combination.

Australia

Australia is considered a major exporter of wheat, barley, meat, wool, and dairy products (Table A.8). Wheat, barley, and oats are grown in southern Australia, whereas grain sorghum dominates the central croplands of Queensland in eastern Australia. Land use is optimized in Australia by rotation between crops and livestock. Southern Australia has historically been known as a cereal-sheep zone, and central Queensland's sorghum fields are a pasture for beef cattle. Therefore, wheat is competing with barley in area whereas sheep grazing is considered a complementary activity. However, due to rotation flexibility, livestock could also compete with cereals.

The government intervention in Australia takes the form of various marketing boards. While the four state barley boards did not have complete control over supplies, the Australian Coarse Grain Marketing Cooperative Association was created in 1970 to present a united front with regard to the export market in particular.

On the demand side, feed grain is fed to animals in case of a drought since most livestock, produced for export and domestic use, are grazed on land. However, pigs and poultry, produced mainly to meet domestic demand, are fed in the feedlots. The major domestic use of barley is in the brewing industry, since the per capita consumption of beer in Australia ranks high in the world. Therefore, the barley produced in Australia is mainly channeled to export markets. As Spriggs (1978) points out, the domestic barley prices are highly correlated with the export prices.

Thailand

Corn is produced in the northeast and central areas of Thailand. It is planted two times a year -- once in April or May and once in August or September. If the land is irrigated, as many as three crops could be harvested. Sorghum is also produced and exported, but it is not significant in comparison to corn production. Other export crops, like cassava and rice, also compete with feed grains.

The consumption of feed grains in Thailand is limited (Table A.9), growing rapidly only recently. Almost 70 percent of the total corn production is exported. This proportion was even higher before feed use began to increase. Therefore, corn prices in Thailand follow closely Chicago #2 yellow corn prices.

South Africa (Republic)

Corn is the major feed grain produced in South Africa. South Africa is considered a net exporter of corn, however, due to highly variable weather, production and exports in South Africa are duely variable (Table A.10). Therefore, the role of economic variables is overpowered by the role of adverse weather in explaining the variations in production and exports. Weather variability affects utilization by limiting available supplies, although South Africa has imported grain in years when production is greatly reduced by poor weather. The domestic distribution and storage of imports are subsidized by the government.

The government controls prices and exports through the South African Maize Board. Consumer and producer prices are set by the Board, and the Board is obligated to buy all production. Traditional consumption is considered as a base in determining the inventory acquired by the Board, and the remaining is exported. The subsidies on consumption and exports are financed through a stabilization fund maintained by the Maize Board. Since 1976, South African corn producer prices have been higher than those in the United States (USDA, 1984e). Exports, therefore, have been subsidized through a tender bid system. The higher producer prices are caused by higher production costs, which are threatening the export competitiveness of South Africa.

Japan

The limited and high priced croplands of Japan are devoted to high revenue crops. The most important grains produced in Japan are rice, wheat, and barley. These crops have been supported through government intervention. Nevertheless, barley production has been declining in importance, fluctuating between 200-400 thousand metric tons with no particular trend. The high rate of protection in the rice sector has caused accumulation of stocks. To reduce the rice surplus, the government has subsidized and encouraged the use of rice as feed.

The rapid income expansion and the resulting growth in demand for livestock products, in the absence of a significant domestic supply, have raised the imports of such feeds as sorghum, corn (Table A.11), and soybeans. These are the dominant ingredients of formula feed in Japan, with their share rising from 62 percent in 1965 to 74 percent of formula feed in 1979 (Coyle 1983). Barley, however, is used mainly for the single ingredient simple feeding.

Feed prices in Japan are affected by two institutions, in addition to world market price movements. The Zennoha National Federation, that represents 40 percent of feed manufacturers, sets the price in consultation with the Ministry of Agriculture. These prices are followed by the rest of the industry. In case of a jump in prices, the government intervenes through a "feed-price stabilization fund," and through stock management, to bring feed prices down.

The U.S.S.R.

Grain production is suitable and customary in most parts of the Soviet Union since the generally cool weather does not leave many other alternatives (Table A.12). However, the central parts are known for the production of cotton, fruits, and vegetables. Corn production was introduced and encouraged in the Soviet Union in the 1950s and it has grown in the southern European part, whereas wheat, barley, and oats have always been produced. The Soviet Union is the third largest producer of grain, but it is the largest consumer of wheat and coarse grain. While adverse weather produces a great deal of variation in production, limitations of appropriate infrastructure, inputs, and price incentives have often been cited for the slack in productivity and efficiency by western economists.

In 1965, an emphasis was put on consumption, but at the same time there was a drive for mechanization and productivity improvements in agriculture. Income expansion, together with stable consumer prices, inflated the demand for more luxury feed products, i.e., meat. A response to this demand was made, around 1971, when the protein food consumption target was raised, large-scale livestock production units were expanded, and feed grains were imported. The Soviet Union changed from an exporter of feed grain into an importer in the early 1970s. The oil price boom further raised imports since oil exports provide a good share of foreign exchange earned. The imports kept rising and produced a concern for dependency on the rest of the world for food. The imposition of the 1980 grain embargo caused a change in Soviet agricultural production policy. There are few exporters in the world market for corn, in which the U.S. supplies around 70 percent of the market. On the other hand, in the world wheat market the number and significance of non-U.S. suppliers are higher and the possibility of an embargo-like situation is lower. Therefore, the Soviet policy makers have shifted the emphasis to corn production at the expense of area devoted to wheat (USDA, 1984c). This policy, and the policies aimed at self-sufficiency, were pursued in the 1980 Food Program announced by Brezhnev. The program was in effect in 1982 and advocates more worker incentives and vertical integration with the food system, agro-industrial complex (APK).

The variability in Soviet production is transmitted to its imports. Due to the nature of the Soviet economic system, however, constraints play an important role and Soviet production is considered to restrain consumption, in this study, where acreage is more relevant for the planners in setting consumption targets, and the yield along with the gold price (that pays for the imports) are relevant in determination of imports. Consumer prices have been stable since 1962 and do not play a role in consumption decisions. Limitations of industrial use of feed grain and the significance of feed use explain why the total use behavior has been investigated here. Moreover, since consumption is planned according to the availability of grain, aggregate feed grain consumption is modeled in this study.

Spain

Much of the Spanish land is semiarid and mountainous. Spanish agriculture faces structural problems such as small farm size, rural migration, etc. These factors reflect themselves in lower crop yields compared to the rest of Europe and North America (USDA, 1983). The agronomic conditions are more favorable to barley and impose serious restrictions on the area devoted to corn. Corn production has doubled between 1965-1980, but this growth is entirely due to yield improvements since changes in area are not significant and have no trend in their movement. The area devoted to barley has increased to 3575 thousand hectares, up from 1374 thousand hectares in 1965. The area planted to malting barley jumped in the mid-1970s in response to the growth in consumption of domestic beer.

Spanish policy makers have long been concerned with self-sufficiency. This objective has been followed by the National Wheat Board, and later by the National Grain Board. Although the Spanish economy was opened up in the 1960s, the concern for the growing imports did not disappear. In 1968, the FORRPA (Agency for Marketing and Regulating Prices of Agricultural Products) was created "to establish indicative or guaranteed prices for certain products, to regulate foreign trade, and to administer subsidies and other production aids." SENPA, or the National Agricultural Products Services, "is an older agency absorbed by FORRPA. SENPA buys, handles and stores commodities ... imports certain agricultural inputs that are resold to farmers at below cost ... imports and transports commodities" (USDA, 1982). These agencies follow prices similar to those prevailing in the EC.

Over the last two decades, Spanish grain policies, reflecting the concern with growing imports of feed grains and surplus production in the wheat sector, have raised the feed grain support prices relative to that of wheat. This policy has largely been successful for barley, to which area devoted increased 146 percent from 1960 to 1978, resulting in a 35 percent decline in area planted to wheat (USDA, 1982). There exists a set of guaranteed minimum prices for domestically produced grains. To support it, then, a threshold price is enforced for the imported grain. The threshold price in the case of barley is higher than the minimum guarantee price, whereas the opposite is true for corn and sorghum. Spain joined the EC officially in January 1985.

The expansion in the demand for meat, stimulated by the improvements in the standard of living, has been met through growing imports of feed grain in absence of sufficient domestic production. Imports of raw materials, such as feed stuff, fodder cereals, and oilseeds, now account for about 40 percent of agricultural food imports (EC Commission, 1981-1986). Corn and sorghum are the dominant feed grains imported into Spain. The growth in livestock production is due to a more than 300 percent increase in pig and poultry production, concentrated in northern Spain. The nonfeed demand of feed grain originates primarily from the demand for domestic beer.

Eastern Europe

Eastern Europe, as a region, is among the major importers of feed grains (Table A.13). However, the events of the 1980s, such as the rise in the value of dollar and interest rates, have increased the debt burden on this region. This in turn has caused a decline in their imports of feed grain.

The lack of relevant data and homogeneity of the region, as it concerns the agricultural policies, and to some extent the market structure, produces significant problems in treating these countries as one single region. Therefore, the net feed grain imports of Eastern Europe enters as an exogenous variable, in the model.

High Income East Asia

Some east Asian countries, including Singapore, South Korea, and Taiwan, have been enjoying a high rate of growth, accompanied by a rapid growth in meat demand. On the other hand, land limitation in this region does not allow grain production (Table A.14). Therefore, more than 90 percent of its feed grain demand is imported from abroad. Furthermore, the feed grain imports of these countries have enjoyed a rapid rate of growth. Despite the significance of this region, as a growing import market, only the net trade of this region enters the model as an exogenous variable, due to problems similar to those explained for Eastern Europe.

The Rest of the World

This region includes all other countries not represented in other regions included in this model. Significant importers and exporters such as Saudi Arabia, China, and Mexico are aggregated in this region due to problems involved in dealing with each of them as a separate region. Therefore, the net trade of this region, too, enters the model as an exogenous variable.

CHAPTER III. METHODOLOGY

This chapter discusses the conceptual framework in which the world feed grain market is modeled and the empirical methods utilized for the study. The first section explains the underlying theory, followed by a schematic representation of the model. Then, the type of model chosen is discussed. The next section is a mathematical representation of the model. Then, sources of data used for the study are described. The final section of this chapter outlines the statistical methods utilized for the empirical analysis.

Conceptual Framework

Livestock producers, based on their anticipation of meat demand and input prices, decide each period how many animals to market and how many to feed. These decisions simultaneously determine feed consumption. Therefore, feed grain demand is derived from the demand for meat. Livestock production takes anywhere from three to 18 months, depending on the type of livestock. Therefore, producers base their production decisions on the anticipation of the market situation in more than one period. Here it is assumed that production would take two periods. In this case, production this period is not only a function of the variable inputs in the current period, but also of what is called here the capital stock in the last period. That is:

$$L_t = l_t(F_t, O_t, L_{t-1})$$

where L_t = capital stock at period t,

F_t = feed grain fed at period t,

O_t = other inputs, at period t, and

l_t = an unspecified functional form.

Since capital stock has a salvage value at each period, the profit function (π) would be of a dynamic nature:

$$\pi_t = PL_tL_t - O_tPO_t - O_{t-1}PO_{t-1} - F_tPF_t - F_{t-1}PF_{t-1} - r_{t-1}L_{t-1}$$

where r_{t-1} = purchase price of livestock at first stage,

PO_t = price of other inputs at t;

PF_t = price of feed at t, and

PL_t = price of livestock at final stage.

The producers, then, wish to maximize their profit with respect to the production technology available to them. The Lagrangian problem to be solved is:

$$\max \pounds = \pi - \lambda_1 L_{t-1} - \lambda_2 L_t$$

where λ_1 and λ_2 are the lagrangian multipliers. Satisfying the first order conditions for maximization would then yield a derived demand for feed grain as a function of livestock, feed, and other input prices and the livestock ending inventory in the last period, i.e.,

$$F_t = f_t(PL_t, r_t, PO_t, PF_t, L_{t-1})$$

where f_t is an unspecified functional form.

The nonfeed demand for feed grain is also a derived demand since only a relatively small portion of feed grain is used as a final product. What is not used as feed is transformed by industry into cereals, gasohol, beer, sweeteners, etc. Therefore, the nonfeed demand could be derived in a fashion similar to feed demand, except that production takes place in one period. Thus, final product prices in the present period would enter the demand function.

At planting time, feed grain producers, like most other farmers, do not know with certainty what the price of their product would be at harvest time. However, they can form expectations about future prices based on their knowledge of prices at planting time and other sets of information and experience. Since researchers do not have access to the complete sets of information used by farmers in the world wide market, it is assumed in this study that the farmers' expectations in the planting season are of a naive nature. That is, only the last period's prices of a particular crop and its substitutes affect cropland allocation decisions made at planting period.

The producers' decision, however, is not limited to the number of acres to cultivate; the decision also includes the amount of fertilizer and other variable inputs to be used, and the technology to be adopted. The variable inputs that are used later in the process of production could vary with the policies and a closer estimate of the prices to be received by the producer for the final product. These predictions could be closer to actual prices at harvest time, particularly in the most commercialized and developed countries such as the United States and the EC. Decisions on the usage of variable inputs have an obvious influence on yield. Moreover, yield is also determined by the stage of the technology adopted and by stochastic variations in weather.

Grain producers, like any other economic agent, are believed to maximize their profits (M) subject to the technology adopted by them, i.e., their production function. The problem then becomes:

$$\max M_t = QF_t * PF_t^* - PI_t * I_t,$$

$$\text{s.t. } QF_t = f(I_t, T_t).$$

where QF_t = feed grain production,

PF_t^* = expected feed grain price at t,

PI_t = input price, and

I_t = input.

The solution to this simple maximization problem would lead to the supply function. More complication is introduced into the production decision by providing the producer with an alternating substitute which becomes relevant when, for example, land is fixed. Assuming for the moment that everything planted is harvested and sold, the supply function then would be similar to the following form:

$$QF_t = q(PF^*_t, PS^*, PI_t, T_t)$$

where PS^* = expected price of substitute in production,

T = technology adopted.

QF could be broken into two components; area planted and the yield. With respect to what was discussed earlier, one can deduct two functions; area planted (AF_t) as:

$$AF_t = a(PF^*, PS^*)$$

and the yield per unit of area planted as:

$$YF_t = y(PF^*_t, PI_t, T_t).$$

Total supply in a given year is equal to what is harvested in that year and what is carried over from last year:

$$SF_t = QF_t + BI_t$$

where SF_t = total domestic supply and

BI_t = the beginning inventory.

Part of what is supplied each year is not used by the end of the year and is called ending stock. It is either stored to feed the livestock in the next period, i.e., for transaction purposes, or to sell in the next period, i.e., for speculative purposes. It is assumed here that there is a desired demand for total ending stock (EI_t) for whatever purpose it may be used. Therefore, the total inventory demand could be written as a function of the supply and prices:

$$EI_t = f(Q_t, BI_t, PF_t).$$

A further assumption of equilibrium in the market would lead to the result that the region under study imports from other world market participants in the case of surplus demand condition (ED), and exports its surplus production (ES) to other trading partners.

$$ED = F_t + EI_t - QF_t - BI_t.$$

Turning to the world market now, in the case of feed grain, a country could export one of the feed grains and import one or more of the others. Assuming that all feed grains are perfect substitutes, all trades in different feed grains have been aggregated into the net trade of feed grain for each region. A further assumption of world market equilibrium would then close the partial equilibrium model.

$$ED_t^i - ES_t^i = NM_t^i,$$

$$\sum_{i=1}^{13} NM_t^i = 0$$

where NM = net imports, if NM > 0,

NM = net exports, if NM < 0,

ES = excess supply,

ED = excess demand, and

i = a trading region.

Based on the assumptions made, then, the above equation represents the market clearing condition.

What has been conceptualized holds, in general, for all regions. However, due to differences in market structure and/or data problems for each region, there exist different regional models for each region.

Once the borders are opened to trade, and in the absence of price insulation policies, domestic feed grain prices could no longer be independent of the prices prevailing in the world market. If there exists a perfect market, the domestic price could not enjoy a margin of greater than the sum of the transportation cost and a reasonable importers' profit margin over the world price. That means that in a relation between domestic and world price, such as the following:

$$PF_t^i = Tr_t^i + \alpha^i PF_t^w$$

where Tr_t^i = transportation cost and

PF_t^w = world price of feed grain.

α^i should be equal to one if the market is free, smaller than one in the presence of some protective policies, and equal to zero if the domestic market is completely insulated from the rest of the world.

What has been discussed, so far, with respect to price transmission holds in the regions where world prices, more or less directly, affect prices. In the centrally planned economies, domestic prices change only according to objectives of the planners with regards to the target level of consumption and the income of producers and consumers. World prices play no role in domestic price formation. In the EC, however, world prices, as hypothesized previously, enter indirectly into the policy price formation process through their effect on import revenue, export refunds, and ultimately through budget pressure.

In light of what has been explained about the relation between policy prices and other components and functions of the CAP (Chapter II), and as is illustrated in Figures 2.5 and 3.1. The hypothesized relationship between policies and economic variables is defined below:

<u>Expected EC budget expenditure</u>

(1) $BE_t^* = EX_t^* * ER_t^* + SC_t^* + MCA_t^*$,

<u>Expected export refund per unit</u>

(2) $ER^* = P_t^{m*} - P_t^{fob*} * E_t^*$,

<u>Expected EC budget revenues</u>

(3) $BR_t^* = IM_t^* * VL_t^*$,

<u>Expected variable levy per unit</u>

(4) $VL_t^* = P_t^{th} - P_t^{cif*} * E_t^*$,

<u>Expected budget deficit</u>

(5) $BP_t^* = BE_t^* - BR_t^*$,

Then, substituting (1)-(4) into (5) yields:

$$(6)\ BP_t^* = EX_t^* \bullet (P_t^{*m} - PW_t^{*fob} * E_t^*) + SC_t^* + MCA_t^* - IM_t^* \bullet (P_t^{th} - P_t^{*cif} * E_t^*) \text{ and}$$

$$(7)\ P_t^{th} = f(CPI^*, BP_t^*)$$

so that (7) is a policy reaction function.

where BE = budget expenditure,

EX = export,

ER = export refund,

SC = storage cost,

MCA = monetary compensatory amount,

P^m = market price in ECU,

P^{fob} = fob export price at Rotterdam in \$,

E = exchange rate ECU/\$,

BR = budget revenue,

IM = import,

VL = variable levy,

P^{th} = threshold price in ECU,

P^{cif} = cif import price at Rotterdam in \$,

BP = budget pressure,

CPI = inflation rate,

t = time period, and

* = expectations.

Now, assuming:

- there is only one price policy and that is threshold price,

- market price is equal to the threshold price,
- there is only one world price (PW), i.e., the export and import price levels are equal, and
- expectations are of naive form (except for CPI and SC),

the budget pressure (deficit) could be further simplified as:

$$BP^*_t = (EX_{t-1} - IM_{t-1})\ (P^{th}_t - P^{cif}_{t-1} * E_{t-1}) + SC + MCA.$$

The simultaneous solution of the above equation and the hypothesized policy price formation equation would reduce the policy response equation to the following:

$$P^{th} = f(CPI_t,\ (EX_{t-1} - IM_{t-1}),\ P^W_{t-1},\ SC,\ MCA).$$

Figure 3.1 is a graphic representation of the model.

Model Type

To study the influence of the world market conditions on the particular sector of a country, some studies divide the world, as Thompson (1981) states: "...into two groups: the one of interest and all others. Two-region models are basically domestic sector agricultural models that are open to international trade." The underlying assumption, then, is that the rest of the world responds similarly to the developments in the market of interest, i.e., the market structure is the

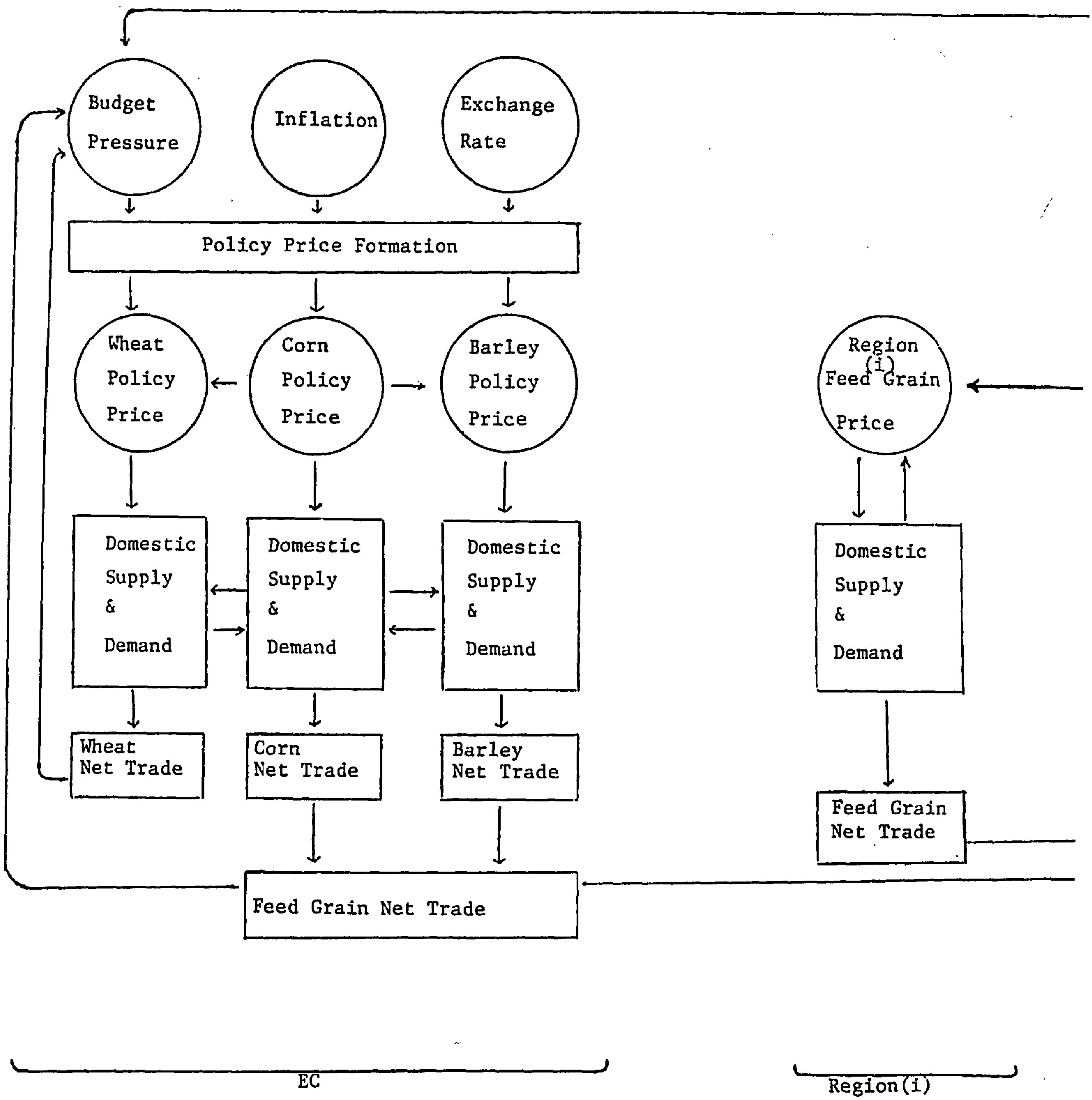
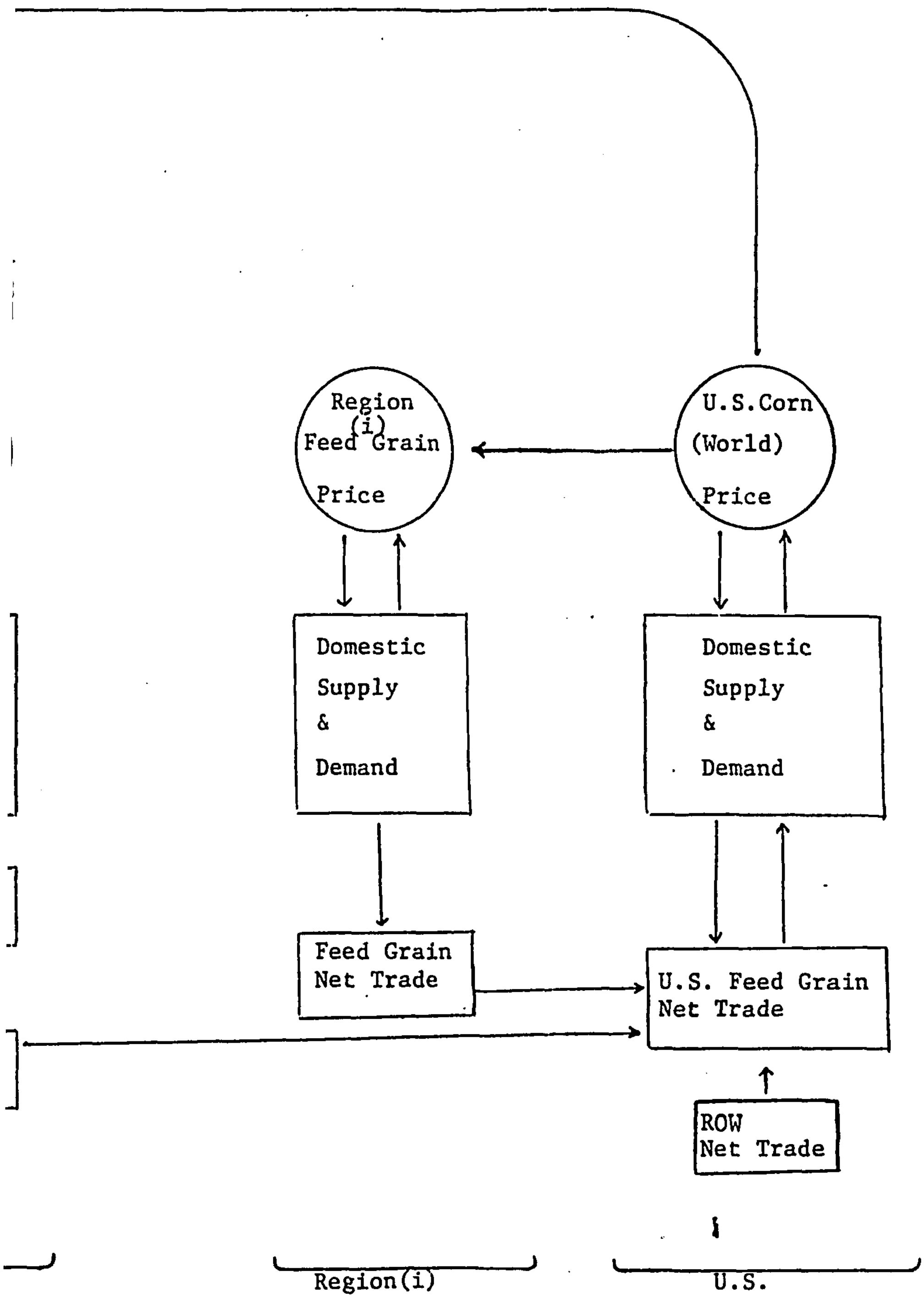


Figure 3.1. Schematical representation of the world feed grain trade model



vorld feed grain trade model

same in all other regions. This assumption is a major shortcoming for these models.

Other trade models analyze behavioral relationships not only in the market of interest but also in other regions active in the world market. These models are called multi-règion trade models. The more thoroughly these other regions are modeled, the more accurate the impacts may be predicted. These multi-region models could, further, be categorized into spatial and nonspatial price equilibrium models. As defined by Thompson (1981), the nonspatial price equilibriums models "explicitly treat the interrelations among trading regions by assuming that the world market price is determined simultaneously by the supply-demand balance in all trading regions such that the global market clears. The model solution gives the world market-clearing price(s) and net trade of each region trading in the world market, but it provides no information on source-destination trade flows." The spatial price equilibrium models, however, have the ability to determine the trade flows and the market shares. The latter models are most useful when the study is concerned with the impacts of establishing quantitative trade restrictions such as quotas and embargoes.

This study intends to assess the impact of price policies on the trade in each of the several regions in the model. Therefore, a nonspatial multi-region model has been chosen to carry the relevant analysis.

Mathematical Representation

This section lays out a general mathematical representation of the model, including the general behavioral equations and identities of the EC, U.S., and a representative region (i). The expected signs for each coefficient, as suggested by the underlying economic theory, are also displayed. The variables are defined at the end of this section.

EC

$$(1)\ \text{FGPTHEC} = \text{f}(\overset{(+)}{\text{CPIEC}},\ \overset{(+)}{\text{lag(FGNMTEC)}},\ \overset{(-)}{\text{lag(FGEXPEC)}},\ \overset{(?)}{\text{lag(NAEXREC * FGPWHU9)}});$$

$$(2)\ \text{FGAHHEC} = \text{f}(\overset{(+)}{\text{(FGPTHEC/CPIEC)}},\ \text{(WHPTHEC/CPIEC)};$$

$$(3)\ \text{FGYIHEC} = \text{f}(\overset{(+)}{\text{(FGPTHEC/FRCPIEC)}},\ \text{T});$$

$$(4)\ \text{FGUFEEC} = \text{f}(\overset{(+)}{\text{(NANPDEC/CPIEC)}},\ \overset{(-)}{\text{(FGPTHEC/CPIEC)}},\ \overset{(+)}{\text{(SMPIMEC/CPIEC)}});$$

$$(5)\ \text{FGUHTEC} = \text{f}(\overset{(+)}{\text{(NANPDEC/CPIEC)}},\ \overset{(-)}{\text{(FGPTHEC/CPIEC)}});$$

$$(6)\ \text{FGNMTEC} = \text{FGUFEEC + FGUHTEC + FGCOTEC - FGYIHEC * FGAHHEC - lag(FGCOTEC)}.$$

U.S.

$$(7)\ \text{FGAPHU9} = \text{f}(\overset{(+)}{\text{lag(FGPWHU9/CPIU9)}},\ \overset{(+)}{\text{(FGPESU9/CPIU9)}});$$

$$(8)\ \text{FGYIHU9} = \text{f}(\overset{(+)}{\text{(FGPESU9/FQCPIU9)}},\ \overset{(+)}{\text{T}},\ \overset{(-)}{\text{FGAPHU9}});$$

$$(9)\ \text{FGAHHU9} = \text{f}(\overset{(+)}{\text{FGAPHU9}});$$

$$(10)\ \text{FGPWHU9} = \text{f}(\overset{(-)}{\text{(FGUFEU9)}},\ \overset{(+)}{\text{(SMPWHU9/CPIU9)}},\ \overset{(+)}{\text{LVCPIU9}});$$

$$(11)\ \text{FGUHTU9} = \text{f}(\overset{(-)}{\text{(FGPWHU9/CPIU9)}},\ \overset{(+)}{\text{T}},\ \overset{(+)}{\text{SWTCPIU9}});$$

$$\text{(12) FGCOTU9} = f(\overset{(-)}{(\text{FGPWHU9}/\text{CPIU9})}, \overset{(+)}{(\text{FGAHHU9} * \text{FGYIHU9})}, \overset{(+)}{\text{lag}(\text{FGCOTU9})});$$

$$\text{(13) FGUFEU9} = \text{FGNMTU9} - (\text{FGUHTU9} + \text{FGCOTU9} - \text{lag}(\text{FGCOTU9}) - \text{FGYIHU9} * \text{FGAHHU9}).$$

Region (i)

$$\text{(14) } \text{FGAHHR}_i = f(\overset{(+)}{\text{lag}(\text{FGPWHR}_i/\text{CPIR}_i)}, \overset{(-)}{\text{lag}(\text{SUBPWHR}_i/\text{CPIR}_i)});$$

$$\text{(15) } \text{FGUDTR}_i = f(\overset{(-)}{(\text{FGPWHR}_i/\text{CPIR}_i)}, \overset{(+)}{\text{LVCACR}_i}, \overset{(+)}{(\text{SUBPWHR}_i/\text{CPIR}_i)});$$

$$\text{(16) } \text{FGPWHR}_i = f(\overset{(+)}{\text{FGPWHU9} * \text{NAEXRR}_i});$$

$$\text{(17) } \text{FGNMTR}_i = \text{FGUDTR}_i + \text{FGCOTR}_i - \text{FGAHHR}_i * \text{FGYIHR}_i - \text{lag}(\text{FGCOTR}_i).$$

Market clearing identity

$$\text{(18) FGNMTU9} = -\text{FGNMTEC} - \sum_{i=3}^{12} \text{FGNMTR}_i - \text{FGNMTRS}$$

where the regions could be defined with the last two letters at the end of each variable:

EC = European community,

U9 = United States,

R_i = region i, and

RS = rest of the world.

The rest of the letter codes are defined as follows:

CPI = consumer price index,

FGAHH = feed grain area harvested,

FGAPH = feed grain area planted,

FGEXP = guaranty expenditures on feed grain (applies to EC only)

FGYIH = feed grain yield per unit harvested,

FGUFE = feed grain feed use,

FGUHT = feed grain food use,

FGUDT = feed grain total use,

FGCOT = feed grain ending stock,

FGPES = feed grain effective support price,

FGPTH = feed grain threshold price,

FGPWH = feed grain wholesale price,

FGNMT = net imports,

LVCPI = livestock price index,

NANPD = national income,

NAEXR = exchange rate,

SMPIM = soymeal import price,

SMPWH = soymeal wholesale price,

SUBPWH = substitute wholesale price,

SWTCPI = sweetener price index,

T = trend, and

WHPTH = wheat threshold prices.

Data Sources

All of the data related to supply and utilization of feed grains and wheat come from CTAP (1985). These data originate from the U.S. Department of Agriculture. The majority of the data on producer and market prices originate from F.A.O. production and trade year books. The data on EC prices, expenditures, and different indexes originate from several publications by the EC Commission. International Financial

Statistics is the source for the data on exchange rates, income, and gold price in different regions.

Other sources have also been utilized for some variables, not included in the above set of variables. The source for each variable will be described later in the study.

Statistical Method

The model, as presented in the last section, includes nonlinear behavior equations (e.g., equation (12)), as well as nonlinear identities. Therefore, the model is considered to be of a nonlinear nature. Moreover, the endogenous variables in this model, as mentioned in the previous section, enjoy a simultaneous relationship.

Consider a nonlinear regression equation:

$$y_i = f_i(Y_i, X_i, \beta) + u_i$$

where y_i is a scalar random variable, Y_i is a vector of variables determined elsewhere in the model, X_i is a vector of predetermined variables, u_i is a scalar random variable with zero mean and constant variance, β is a vector of unknown parameters, and f_i is an unspecified nonlinear functional form. Since $E(y_i u_i) \neq 0$, and y_i itself is a factor explaining some of the variations in Y_i elsewhere in the system, then $E(Y_i u_i) \neq 0$. The parameters estimated by OLS technique will be biased in this case. To correct this problem, nonlinear two-stage least squares (NL2SLS) procedure should be used. Amemiya (1974) shows that under certain conditions, N2SLS estimators are asymptotically unbiased with normal distribution.

At the first stage, the system is solved for the reduced form equations where $\hat{Y}_t$ is arrived at as a function of all the exogenous variables. When the number of exogenous variables in the system exceeds the total number of observations, the principal component technique is applied in order to reduce the number of instrumental variables to be used at the first stage. The more instruments used, the more is the gain in efficiency. On the other hand, the more excess of observations over the total number of instruments used in one equation, the more bias is eliminated. Therefore, in a finite sample such as the one used in this study, there is a trade off between efficiency and bias. As is indicated in SAS (1985), there is no known: "...method for choosing an optimal number of instruments." This study utilizes seven principal components to allow for some degree of freedom. In the second stage, Y is used in the structural equation to arrive at the β, the N2SLS estimator of β.

N2SLS requires the use of iterative methods. For example, the Gauss-Newton method, based on a defined convergence criteria, keeps iterating until the derivative of residual with respect to parameter could no longer be improved in the estimation stage.

Simulation, accordingly, follows a nonlinear simultaneous procedure. The numerical solution method for simulation is, then, iterative. For example, the Newton iteration method for simulation keeps iterating as long as there is an improvement in the derivative of residual with respect to endogenous variables, based on a defined convergence criteria.

CHAPTER IV. EMPIRICAL RESULTS

This chapter presents the results of estimation and simulation, subsequently. The numerical solution used to carry out the estimation procedure is the Gauss-Newton method, as explained in the last chapter. Seven principal components have been used as instrumental variables, replacing the numerous exogenous variables in the model. The model is divided into several submodels (for the sake of presentation), each representing one region. For each submodel, there exists a table, presenting the equations, as estimated, and the related statistics such as t statistics, DW test, and R square. It should be noted, again, that t statistics hold only asymptotically. Furthermore, elasticities have been calculated for each relevant coefficient and are shown inside the brackets. However, one needs to be careful while interpreting these elasticities since in a simultaneous system, partial derivatives are not strictly valid.

The EC Submodel

The EC submodel includes wheat and soymeal models, as well as feed grains. Wheat is an important domestic substitute crop both in production, and in consumption. Soymeal is an important substitute both in domestic consumption, and in imports. Their inclusion is intended to increase the validity of the substitution effects and the policy response parameters estimated by the model.

Equations (1)-(3) in Table 4.1 explain the relation between Rotterdam prices and the U.S. prices for corn, barley, and wheat. There exists significant relationship between these prices, as expected. However, the barley prices in Rotterdam are not as responsive as corn and wheat to the U.S. prices. This is also expected since the U.S. does not have a significant role in the world barley market and the kind of barley imported to the EC comes from Canada and Australia. Equation (4) represents the policy response equation, as conceptualized in Chapter III. The most significant factors explaining the policy prices are the inflation rate and the self-sufficiency factor (as reflected in net imports), with elasticities of .71 and .14, respectively. The variables reflecting the world prices and budget pressure are not suggested to have a significant effect on policy determination in this model. This could be explained by the fact that the latter factors have become significant in the 1980s, whereas the estimation period covers from 1968 to 1982. This equation explains 98 percent of the variations in the threshold price of corn.

Equation (5) suggests an own price elasticity of .84 for food use of corn, and own price explains 85 percent of variations in this variable. Feed use of corn in the EC is more responsive to soymeal prices than it is to corn price since soymeal, over time, has become an important substitute for corn in the feed formulas. Furthermore, the changes in feed demand are due, more than any other factor, to income expansion. The estimation results (equation (6)) are consistent with the above observation. The dummy variables for 1973, 1976, and 1981 explain the

Table 4.1. Estimated model of the EC soymeal, feed grain, and wheat sectors

Equation	R^2	D.W.
(1) COPIMEO = 21.3 + 1.17 * (COPFMU9 * N1MEUEO)	.96	1.6
(3.5) (14.9)		
[.8]		
(2) BAPIMEO = 3.6 + .78 * (BAPFMU9 * N1MEUEO)	.75	1.9
(2.9) (5.9)		
[.65]		
(3) WOPIMEO = 13.28 + .94 * (WHPFMU9 * N1MEUEO)	.79	.76
(.8) (6.5)		
[.87]		
(4) COPTHEO = 23.3 + .00198 * LAG(COSMNEO + BASMNEO)	.98	2.5
(.8) (1.18)		
[.14]		
+ .025 * LAG(COPIMEO) - .011 * LAG(MCAEO)		
(.19) (-.55)		
[.01] [-.02]		
- .0187 * LAG(CGCOCEO) + 102 * CPIEO		
(-.34) (4.5)		
[-.01] [.71]		
Soymeal sector		
(20) SMUFEEO = 3571.8 + 1.2 * (SMPIMEO/CPIEO) + 16.5	.94	1.4
(.31) (.14) (5.5)		
[.02] [4.8]		
* LVCHPEO - .74 * (WHUFEEO + COUFEEO + BAUFEEO)		
(-2.1)		
[-4.2]		
(21) SMSMNEO = SMUFEEO - LAG(SMCOTEO) - SMSPREO + SMCOTEO		
Corn sector		
(5) COUHTEO = 11621 - 35.6 * (COPTHEO/CPIEO)	.85	1.6
(17.2) (-8)		
[-.84]		

Table 4.1. continued

Equation	R^2	D.W.
(6) COUFEEO = 2750.9 + 14.6 * (NANPDEO/CPIEO) - 3.5	.71	2.6
(.26) (2.4) (-.12)		
[.73] [-.02]		
* (COPTHEO/CPIEO) + 9 * (SMPIMEO/CPIEO)		
(1)		
[.07]		
+ 2266.9 * DM17376 - 1733 * DM181		
(2.5) (-.65)		
(7) COYIHEO = -316.9 + .16 * YEAR + 1	.87	1.7
(-2.4)(2.5) (.98)		
[.3]		
* (COPTHEO/LAG(CPIFREO)) + .64 * DM18182		
(2.2)		
- .32 * DM172176		
(-1.2)		
(8) COSPREO = COYIHEO * COAHHEO		
(9) COSMNEO = COUFEEO + COUHTEO - COSPREO - LAG(COCOTEO) + COCOTEO		
(10) BAPTHEO = BAPDFEO + COPTHEO		
[.99]		
(11) BAAHHEO = 9651 + 7.78 * BAPTHEO - .56 * OAAHHEO	.77	2.7
(4.5) (1.3) (-1.0)		
[.13] [-.15]		
- 704 * DM18182		
(-2.8)		
(12) BASPREO = BAAHHEO * BAYIHEO		
(13) BAUHTEO = 9397 - 24.9 * (BAPTHEO/CPIEO) + 2.8	.77	.92
(3.2) (-3.2) (1.5)		
[-.42] [.04]		
* (NANPDEO/CPIEO)		

Table 4.1. continued

Equation	R^2	D.W.
(14) BAUFEEO = 24162 + 6.5 * (NANPDEO/CPIEO) - 31.8 (7) (2.9) (-3.2) [.27] [.18] * (BAPTHEO/CPIEO) + .12 * (SMPIMEO/CPIEO) (.03) [.001] - 1617.8 * DM17576 (-3.2)	.89	2.5
(15) BASMNEO = BAUFEEO + BAUHTEO + BACOTEO - BASPREO - LAG(BACOTEO)		
WOPTHEO = WOPDFEO + COPTHEO (.9)		
(16) WHUFEEO = 29217 - 41.8 * (WOPTHEO/CPIEO) - 319 (4.8) (-3.2) (-.73) [-.55] * DM180 - 2579 * DM17576 - 5.7 (3.26) (-.5) [-.51] * (NANPDEO/CPIEO) + 11.7 * (SMPIMEO/CPIEO) (2.23) [.15] - .26 * COUFEEO (-.6) [-.45]	.93	3.4
(17) WHYIHEO = -372 + 1.2 * (WOPTHEO/LAG(CPIFREO)) (-5.6) (2.7) [.56] + .189 * YEAR - .42 * DM176 (5.7) (-1.9)	.94	3.1
(18) WHSPREO = WHYIHEO * WHAHHEO		
(19) WHSMNEO = WHUFEEO + WHUHTEO - LAG(WHCOTEO) - WHSPREO + WHCOTEO		

Endogenous

BAAHHEO = barley area harvested, 1000 ha, USDA

BAPTHEO = barley threshold price, ECU/MT, Eurostat

Table 4.1. continued

BAPIMEO	=	barley import price, ECU/MT, Eurostat
BASMNEO	=	barley net imports, 1000 MT, USDA
BASPREO	=	barley production, 1000 MT, USDA
BAUFEEO	=	domestic feed use, 1000 MT, USDA
BAUHTEO	=	domestic food use, 1000 MT, USDA
COPIMEO	=	corn import price, ECU/MT, Eurostat
COPTHEO	=	corn threshold price, ECU/MT, Eurostat
COSMNEO	=	corn net imports, 1000 MT, USDA
COSPREO	=	corn production, 1000 MT, USDA
COUFEEO	=	corn domestic feed use, 100 MT, USDA
COUHTEO	=	corn domestic food use, 1000 MT, USDA
COYIHEO	=	corn yield, MT/ha, USDA
FGSMNEO	=	feed grain net imports, 1000 MT, USDA
SMSMNEO	=	soymeal net imports, 1000 MT, USDA
SMUFEEO	=	soymeal feed use, 1000 MT, USDA
WOPTHEO	=	wheat threshold price, ECU/MT, Eurostat
WHSMNEO	=	wheat net imports, 1000 MT, USDA
WHSPREO	=	wheat production, 1000 MT, USDA
WHUFEEO	=	wheat feed use, 1000 MT, USDA
WHYIHEO	=	wheat yield, MT/ha, USDA
Exogenous		
BACOTEO	=	barley ending stocks, 1000 MT, USDA
BAPFMU9	=	U.S. barley farmprice, $/MT, USDA
BAYIHEO	=	barley yield, MT/ha, USDA
CGCOCEO	=	grain storage cost, 1000 ECU, Eurostat
COAHHEO	=	area harvested, 1000 ha, USDA
COCOTEO	=	ending stocks, 1000 MT, USDA
COPFMU9	=	U.S. corn farm price, $/MT, USDA
CPIEO	=	consumer price index, USDA
CPIFREO	=	fertilizer price index, USDA
DM1812	=	dummy variable equal to one in 1981 and 1982, zero otherwise
LVCHPEO	=	livestock price index,
MCAEO	=	monetary compensatory amount, 100000 ECU, Eurostat
NANPDEO	=	GDP nominal, bill. of ECU, USDA
N1MEUEO	=	exchange rate, ECU/US$, Eurostat
OAAHHEO	=	oats area harvested, 1000 ha, USDA
OASMNEO	=	oats net imports, 1000 MT, USDA
OSAHHEO	=	oats and sorghum are harvested, 1000 ha, USDA
SGSMNEO	=	sorghum net imports, 1000 MT, USDA
SMCOTEO	=	soymeal ending stock, 1000 MT, USDA
SMPIMEO	=	soymeal import price, ECU/MT, USDA
SMSPREO	=	soymeal production, 1000 MT, USDA
WOPDFEO	=	wheat threshold price difference with corn threshold price, ECU, calculated
WHAHHEO	=	wheat area harvested, 1000 ha, USDA
WHPFMU9	=	U.S. wheat farm price, $/MT, USDA
WHUHTEO	=	wheat food use, 1000 MT, USDA
WHCOTEO	=	wheat ending stock, 1000 MT, USDA

effect of the sudden change in the world market situation, the drought in Europe, and the policy changes, respectively.

The area planted in corn has been taken as exogenous since the increase in production is in major part due to yield improvements. This is especially the case in Italy, which produces a major share of the EC corn production. The changes in yield (equation (7)) are responsive to the relation between corn and fertilizer price for which the elasticity is 0.3. The technological improvements, represented by a monotonic trend, however, are suggested to play the most important role. Dummy variables for 1972 and 1976 are introduced to capture the effect of drought. The dummy variables for 1981 and 1982 represent the effect of some new factors. Total production and net imports are arrived at through identities, as outlined in equations (8) and (9).

Equation (10) relates the barley threshold price to the corn threshold price through an identity. These two prices are practically identical after 1976. Area harvested for barley, as represented by equation (11), has an elasticity of 0.13 with respect to its own price. It is also suggested by this equation that 0.56 hectare out of every one hectare, withdrawn from oats and sorghum production, is planted in barley. The dummy variables for 1981 and 1982 represent some new unknown policy or preference changes. The variables in this equation explain 77 percent of variation in the barley area. The barley yield variations are assumed to be caused by some exogenous factors and, hence, enter the model as exogenous variables. Total production, then, is arrived at through an identity.

The food use of barley (equation (13)) is most significantly related to the real barley price with an elasticity of -0.42. Real income also explains some of the variations in barley food use, with an elasticity of 0.04. These variables explain 77 percent of the variations in barley food use. The most important factor affecting the barley feed use, as in equation (14), is its own price which is related to an elasticity of 0.18. Real income is as significant in barley feed use as it was in corn feed use. On the other hand, soymeal prices are not suggested to be a significant substitute for barley in feed use. The variables in equation (14) explain 89 percent of the variations in feed use. Equation (15), then, determines the net import of barley through an identity.

The difference between wheat and corn price has almost stayed the same. Therefore, the use of identity to relate these prices does not seem to be out of line with actual observations. Wheat feed use is suggested to be much more elastic with respect to its own price (elasticity of 0.55), as compared with corn and barley feed use. There also seems to be a close substitution between corn (the commodity in deficit), and wheat (the commodity in surplus) in feed use (in the EC) due to policies that may not necessarily be price related. However, equation (16) suggests that this relation is not significant. This equation also suggests a significant substitution between wheat and soymeal (substitution elasticity of 0.15) and a significant response to changes in real income. Of variations in wheat feed use, 93 percent are explained by the variables included in equation (16).

Equation (17) indicates a significant relation between the wheat yield and the wheat fertilizer price ratio. Nevertheless, technological advances represented by trend have the most significant role in the yield improvements. These variables explain 94 percent of variation in yield. As the changes in wheat production are almost entirely due to changes in yield, the area harvested is exogenized in this model. Equation (18) arrives at total production through an identity. Similarly, equation (19) calculates the net import of wheat.

Since soybean production has not been of significance in the EC, it does not enter the model endogenously. However, soymeal feed use and its substitution for feed grains in feed use are of major importance. Therefore, soymeal feed use is endogenous and is significantly explained by feed grains feed use. Livestock prices play an even more significant role in determination of the soymeal feed use while its own price produces the wrong sign, and is not significant. The variables in this equation (20) explain 94 percent of variation in the soymeal feed use. Soymeal net imports then, are arrived at in equation (21).

The United States Submodel

The United States is the only region for which area planted has been modeled both because of the availability of the data, and because of the several policies directly affecting the acreage planted. Equation (22) in Table 4.2 suggests that there is no significant relation between the area planted in corn and its own price. However, policies such as diversion payment play the most significant role. Also, there seems to

Table 4.2. Estimated model of the U.S. feed grain sector

Equation	R^2	D.W.
(22) COAPHU9 = 20824 + .41 * LAG(COAPHU9) - 455.9 (2.41)(1.91) (-2.3) [-.03]	.93	1.85
* (COPDVU9/LAG(WPIU9) + 9.8 * LAG(COPFMU9/WPIU9) (.16) [.01]		
+ DMPIKU9		
(23) COAHHU9 = -3689 + .98 * COAPHU9 (-1.9) (15.7)	.96	1.3
(24) COYIHU9 = -4465 - .66 * DM17080 + 54.8 (-7.2)(-4,2) (2.1) [.16]	.98	2.7
* (COPESU9/CPIFRU9) - .97 * DM174 - .0002 (-4.19) (-4.5) [-1]		
* COAPHU9 + .23 * YEAR (7.2)		
(25) COSPRU9 = COYIHU9 * COAHHU9		
(26) COUFEU9 = -160413 - 780.5 * (COPFMU9/WPIU9) + 608 (-2.13) (-.88) (1.2) [-.33] [.31]	.92	2.5
* (WHFMU9/WPIU9) + 151.8 *(SMPWHU9/WPIU9) (4.5) [.13]		
+ 2471.9 * LVCACU9 + 7831 * WP1LVU9 - 8787 (3.9) (1.1) (-1.8) [2.3] [.14]		
* DM176180		
(27) COUHTU9 = 8298 - 62.8 * (COPFMU9/WPIU9) + 39 (3.2) (-1.4) (8.6) [-.19] [.6]	.90	1.2
* CPISWTU9		

Table 4.2. continued

Equation	R^2	D.W.
(28) COCOTU9 = 35802 - 394.9 * (COPFMU9/WPIU9) + 231 (7.1) (-3.95) (7.3) [-.58] [.38] * (CONENU9 + COCRTU9) - 4182 * DM181182 (-.69)	.98	2.8
(29) BAPFMU9 = -12.4 + 1.2 * COPFMU9 (-1.7)(14.7) [1.1]	.95	2.0
(30) SGPFMU9 = -1.3 + .93 * COPFMU9 (-.27)(17.4) [1.0]	.97	2.1
(31) FGSMNU9 = -FGSMNEQ - FGSMNAR - FGSMNCA - FGSMNAU - FGSMNTH - FGSMNJP - FGSMNSU - FGSMNES - FGSMNE8 - FGSMNR4 - FGSMNRS		
(32) COSMNU9 = FGSMNU9 - OASMNU9 - SGSMNU9 - BASMNU9		

Endogenous

BAPFMU9 = barley producer price, US$/MT, USDA
COAHHU9 = corn area harvested, 1000 ha, USDA
COAPHU9 = corn area planted, 1000 ha, USDA
COCOTU9 = corn ending stocks, 1000 MT, USDA
COPFMU9 = corn producer price, US$/MT, CNFAP
COSMNU9 = corn net imports, 1000 MT, USDA
COSPRU9 = corn production, 1000 MT, USDA
COUFEU9 = corn domestic feed use, 1000 MT, USDA
COUHTU9 = corn domestic food use, 1000 MT, USDA
COYIHU9 = corn yield, MT/ha, USDA
FGSMNU9 = feed grain net imports, 1000 MT, USDA
FGSMNAR = feed grain net imports, Argentina, 1000 MT, USDA
FGSMNAU = feed grain net imports, Australia, 1000 MT, USDA
FGSMNCA = feed grain net imports, Canada, 1000 MT, USDA
FGSMNEO = feed grain net imports, EC(10), 1000 MT, USDA
FGSMNES = feed grain net imports, Spain, 1000 MT, USDA
FGSMNJP = feed grain net imports, Japan, 1000 MT, USDA
FGSMNSU = feed grain net imports, Soviet Union, 1000 MT, USDA
FGSMNTH = feed grain net imports, Thailand, 1000 MT, USDA
SGPFMU9 = sorghum producer price, US$/MT, CNFAP

Table 4.2. continued

Exogenous	
BASMNU9	= barley net imports, 1000 MT, USDA
COCRTU9	= corn FOR stocks, 1000 MT, USDA
CONENU9	= corn CCC stocks, 1000 MT, USDA
COPDVU9	= corn diversion rate, US$/MT, CNFAP
COPESU9	= corn effective support rate, US$/MT, CNFAP
CPIFRU9	= fertilizer price index, paid by farmers, FAO
CPISWTU9	= sweetener's price index, CNFAP
DM17080	= dummy variable, equal to one for 1970 and 1980, zero otherwise
DM176180	= dummy variable, equal to one for 1976 and 1980, zero otherwise
DM181182	= dummy variable, equal to one for 1981 and 1982, zero otherwise
DM172	= dummy variable, equal to one for 1972, zero otherwise
DM174	= dummy variable, equal to one for 1974, zero otherwise
FGSMNE8	= feed grain net imports, eastern Europe, 1000 MT, USDA
FGSMNR4	= feed grain net imports, high income East Asia, 1000 MT, USDA
FGSMNRS	= feed grain net imports, rest of the world, 1000 MT, USDA
LVCACU9	= grain consuming animal units cal. yr., 1000 units, CNFAP
OASMNU9	= oats net imports, 1000 MT
SBPFMU9	= soybean producer price, $/MT, USDA
SGSMNU9	= sorghum net imports, 1000 MT, USDA
SMPWHU9	= soymeal wholesale price, US$/MT
WHPFMU9	= wheat producer price, US$/MT, USDA
WPILVU9	= livestock product wholesale price index, CNFAP
WPIU9	= wholesale price index, CNFAP
YEAR	= year variable from 1967 to 1982

be an important relation between the area planted this period and that of last period. The shift in 1983 in the area planted due to the PIK program is taken care of by a dummy variable. These variables explain 93 percent of the variability in the area. Equation (24) suggests that a one percent reduction in area planted is accompanied by a one percent increase in yield. Furthermore, policy prices, such as loan rates in relation to the fertilizer price index, play a significant role in explaining the variations in yield. However, technological advances are suggested to have the most significant role in yield improvement. These variables, together with the drought dummies, explain 98 percent of the variability in yield. The results, therefore, suggest that yield improvements in the U.S. are in part due to economic factors triggered by government policies, as is the case in the EC as well.

Equation (26) suggests that the relation between corn feed use and its own price is nonsignificant. Feed use, however, is significantly determined by substitute prices such as wheat and soymeal for which the elasticities are 0.31 and 0.13, respectively. The number of grain consuming animal units also affects the feed use in a significant way. These variables, together with the dummy variables for 1976 and 1980, explain 92 percent of variations in feed use. The nonfeed use of corn (equation (27)) is suggested to respond effectively to the variations in the sweeteners price index for which there stands an elasticity of 0.6. This is explained by the rapid growth in the use of corn to produce sweeteners and other by-products. The corn price itself, although significant in the relation, does not enjoy the same relevance and is associated with an elasticity of .2. These two variables explain 90 percent of the variations in nonfeed use. The total ending stock seems to be significantly determined by the real corn price (elasticity of 0.6), as suggested in equation (28). What seems to be even more detrimental is the size of stock held in noncommercial channels. These variables explain 98 percent of the variability in the total ending stock.

Sorghum and barley prices closely follow corn prices, as suggested by equations (30) and (29), and are associated with unitary elasticities. Total U.S. feed grains net imports is calculated as a residual of the world net imports and the sum of the net imports of all other regions, represented in the model (equation (30)). This equation is also an accounting identity resembling the equilibrium condition in the world feed grain market and, hence, closing the market. The U.S. net imports of other feed grains have been exogenized due to their low volume as compared with the volume of corn exports.

Argentina Submodel

Corn and sorghum are the dominant feed grains produced in Argentina. Each of these have been modeled separately. Equation (33) in Table 4.3 suggests that the corn area harvested has a significant inverse relation to the livestock produced in the same period. This is due to double cropping (grain and livestock) in most of the farms. Moreover, corn prices in the last period significantly affect farmer expectations and, hence, their decision with regards to the number of acres planted

Table 4.3. The estimated model of the Argentina feed grain sector

Equation	R^2	D.W.
(33) COAHHAR = 8567 - 106.6 * CECOTAR + 3.2	.84	2.6
(3.6) (3.3) (1.9)		
[-1.8] [.3]		
LAG(COPFMAR/WPIAR) - 1.6 * LAG(WHPFMAR/WPIAR)		
(-.8)		
[-.16]		
+ 368.7 * DM17273		
(1.7)		
(34) COSPRAR = COAHHAR * COYIHAR		
(35) COUDTAR = 4785 - 1756 * (COPFMAR/WHPFMAR) + 772	.76	1.7
(9.97) (-3) (2.2)		
[-4.9]		
* DM169 + 891 * DM17173		
(5)		
(36) SGAHHAR = -703.2 + 1.7 * LAG(SGPFMAR/WPIAR) + 510	.72	1.9
(-.27) (.67) (1.2)		
[.21]		
DM166570 - 1050.9 * DM171179		
(-4.7)		
(37) SGSPRAR = SGAHHAR * SGYIHAR		
(38) SGUDTAR = -162 - 1.6 * (SGPFMAR/WPIAR) + .04	.76	3.0
(-.08) (-.46) (.85)		
[-.02] [.2]		
* CRAHHAR + 47 * CECOTAR - 272.9 * DM177170		
(1.6) (-1.0)		
[.04]		
- 1071.4 * DM175179		
(-4.0)		
(39) COPFMAR = COPDFAR + COPFMU9 * N1MEUAR		
[.84]		
(40) SGPFMAR = SGPDFAR + SGPFMU9 * N1MEUAR		
[.94]		

Table 4.3. continued

Equation	R^2	D.W.
(41) COSMNAR = COUDTAR + COCOTAR - COSPRAR - LAG(COCOTAR)		
(42) SGSMNAR = SGUDTAR + SGCOTAR - SGSPRAR - LAG(SGCOTAR)		
(43) FGSMNAR = COSMNAR + SGSMNAR + OBSMNAR		

Endogenous

COAHHAR = corn area harvested, 1000 ha, USDA
COPFMAR = corn producer price, peso/MT, FAO
COSMNAR = corn net imports, 1000 MT, USDA
COSPRAR = corn production, 1000 MT, USDA
COUDTAR = corn total domestic use, 1000 MT, USDA
FGSMNAR = feed grain net imports, 1000 MT, USDA
SGAHHAR = sorghum area harvested, 1000 MT, USDA
SGPFMAR = sorghum producer price, peso/MT, World Bank
SGSMNAR = sorghum net imports, 1000 MT, USDA
SGSPRAR = sorghum production, 1000 MT, USDA
SGUDTAR = sorghum domestic feed use, 1000 MT, USDA

Exogenous

CECOTAR = ending stock of cattle, 1000 head, World Bank
COCOTAR = ending stock, 1000 MT, USDA
COPDFAR = corn price differential, peso/MT, calculated
COYIHAR = corn yield, MT/ha, USDA
CRAHHAR = feed grains and soybean area harvested, 1000 ha, USDA
DM1692 = dummy variable equal to one in 1969, zero otherwise
DM166570 = dummy variable equal to one in 1966, two in 1967, ..., five in 1970, zero otherwise
DM177170 = dummy variable equal to zero in 1975 and 1977, zero otherwise
DM17273 = dummy variable equal to one from 1972 to 1973, zero otherwise
DM17173 = dummy variable equal to one in 1971 and 1979, zero otherwise
DM171591 = dummy variable equal to one in 1971, 1975, 1979, and 1981, zero otherwise
DM171179 = dummy variable equal to one in 1971 and 1979, zero otherwise
HGCOTAR = hog ending stock, mil. head, World Bank
NIMEUAR = exchange rate, peso/US$, IMF-IFS
OBSMNAR = oats and barley net imports, 1000 MT, USDA
SGCOTAR = sorghum ending stocks, 1000 MT, USDA
SGPDFAR = Sorghum price differentials, peso/MT, calculated
SGYIHAR = sorghum yield, MT/ha, USDA
WHPFMAR = wheat producer price, peso/MT, FAO
WPIAR = wholesale price index, IMF-IFS
YEAR = year variable from 1967 to 1982

(elasticity of 9.3). But, the competing grain, wheat, does not seem to be a significant factor in farmers' decisions. These variables, together with the dummy variables for 1972 and 1973, explain 84 percent of variations in the area harvested of corn. Total use of corn (equation (35)) is suggested to be significantly affected by the relative movements of corn and wheat prices. This ratio, together with the dummy variables for 1969, 1971, and 1973, explain no more than 76 percent of the variations in total use.

Equation (36) suggests that the area devoted to sorghum is not significantly explained by the sorghum prices in the last period. The economic variables affecting the farmers' decision, in this case, have remained unknown in this model and basically the dummy variables, DM166570 (which represents the years of structural change due to government sorghum production promotion programs) and the dummy variable for drought are not able to explain more than 72 percent of the variations in the sorghum area harvested. The only significant relation in equation (38) exists between the livestock and total sorghum use. This is also a poor equation with only 76 percent of its variability being explained. The price transmission equations are in the form of identities since there have been several shifts in policies related to price, which needs more than one simple equation to explain them. Differences between domestic and world price (COPDFAR) has been simply calculated, representing the combination of export tax, transportation cost, etc. These identities imply transmission elasticities of 0.84 and 0.94 for corn and sorghum prices, respectively.

Canada Submodel

Corn and barley, as the more important feed grains, have been modeled for Canada. Since these grains are grown in different regions of Canada and are under the effect of different policy structures, on the supply side they have been modeled separately. Equation (44) in Table 4.4 shows that the barley area harvested is significantly determined by the prices, in the last period, of both barley and wheat (elasticities of 1.5 and -1.1, respectively). It is also suggested by this equation that there exists a significant positive trend in the area devoted to barley. These variables, together with the dummy variables for 1976, 1971, and 1972, explain 40 percent of variation in the barley area harvested. In the eastern part of Canada where corn is grown, soybeans are competing for area. Equation (46) suggests that the area devoted to corn in this period is relatively affected more by soybean prices than by corn prices in the previous crop year (elasticities of -0.45 and 0.23, respectively). In the case of corn, also, there seems to exist a highly significant positive trend in the area harvested. These variables and the dummy variables for 1973 and 1974 explain 94 percent of the variations in corn area.

The sum of total use of barley and corn is shown to have a significant relation with the size of grain consuming animal units and also with soymeal prices, which is a substitute in feed use. Other prices do not play a significant role in this equation. All these variables explain 92 percent of variations in the total use. Price transmission, as expected, enjoys a unitary elasticity in the case of

Table 4.4. Estimated model of Canadian feed grain sector

Equation	R^2	D.W.
(44) BAAHHCA = -488168 + 248 * YEAR + 15188	.4	3.4
(-1.9) (1.98) (1.6)		
[1.5]		
* LAG(BAPOBCA/WPIFPFCA) - 2242 * DM176 - 8365		
(-1.3) (-1.3)		
[-1.1]		
* LAG(WHPFMCA/WPIFPFCA) + 307.9 * DM17172		
(.35)		
(45) BASPRCA = BAAAHHCA * BAYIHCA		
(46) COAHHCA = -104400 + 332 * LAG(COPFMCA/WPIFPFCA)	.94	1.5
(-10) (.7)		
[.23]		
+ 53 * YEAR - 292.4 * LAG(SBPFMCA/WPIFPFCA)		
(10) (-1.3)		
[-.45]		
+ 47.6 * DM17374		
(.4)		
(47) COSPRCA = COAHHCA * COYIHCA		
(48) CBUDTCA = -1124 + 561 * LVCACCA - 4724	.92	1.6
(-.39) (3.2) (-1)		
[.95] [-.2]		
* (BAPOBCA/WPIFPFCA) + 24.8 * CPILVCA		
(1.32)		
[.16]		
+ 1993.7 * (WHPFMCA/WPIPFPCA) + 981		
(.72) (1.5)		
[.11] [.1]		
* (SMPWHCA/WPIFPFCA)		
(49) COPFMCA = 2.5 + .99 * (COPFMU9 * N1MEUCA)	.96	1.8
(.41) (16.4)		
[.96]		

Table 4.4. continued

Equation	R^2	D.W.
(50) BAPOBCA = 15.6 + .79 * (BAPFMU9 * N1MEUCA)	.91	1.1
(2) (10.7)		
[.82]		
(51) CBSMNCA = CBUDTCA + BACOTCA + COCOTCA - BASPRCA		
- COSPRCA - LAB(BACOTCA) - LAB(COCOTCA)		
(52) FGSMNCA = CBSMNCA + OSSMNCA		

Endogenous

BAAHHCA = barley area harvested, 1000 ha, USDA
BAPOBCA = off-board barley price, CA$/MT, Ag. Canada
BASPRSA = barley production, 1000 MT, USDA
CBSMNCA = corn and barley net imports, 1000 MT, USDA
CBUDTCA = corn and barley domestic use, 1000 MT, USDA
COAHHCA = corn area harvested, 1000 ha, USDA
COPFMCA = corn producer price, CA$/MT, FAO
COSPRCA = corn production, 1000 MT, USDA
FGSMNCA = feed grain net imports, 1000 MT, USDA

Exogenous

BACOTCA = barley ending stocks, 1000 MT, USDA
BAYIHCA = barley yield MT/ha, USDA
COCOTCA = corn, ending stock, 1000 MT, USDA
COYIHCA = corn yield, MT/ha, USDA
CPILVCA = weighted average livestock product price index, FAO
DM171 = dummy variable equal to one for 1971, otherwise zero
DM17374 = dummy variable equal to one for 1973 and 1974, otherwise zero
LVCACCA = grain consuming animal units, 1000 head
NIMEUCA = exchange rate, CA$/US$, IMF-IFS
OAAHHCA = oats area harvested, 1000 ha, USDA
OSSMNCA = oats and sorghum net imports, 1000 MT, USDA
SBPFMCA = soybean producer price, CA$/MT, Ag. Canada
SMPWHCA = wholesale soymeal price, CA$/MT, Ag. Canada
WHPFMCA = wheat producer price, CA$/MT, FAO
WPIFPFCA = farm wholesale price index, FAO
YEAR = year variable from 1967 to 1982

corn, due to lack of protection for this commodity. Transmission elasticity for barley (equation 50) is only 0.82, due to the policies followed in this sector. The barley price used here is the off-board price, nevertheless it is affected by the government policies.

Australia Submodel

Barley is the only crop modeled for Australia. Equation (53) in Table 4.5 seems to indicate that prices do not play a significant role, rather the area in the last period plays the major role in determination of the area devoted to barley this period. These variables together with the dummy variable for 1971 and 1972 explain only 64 percent of the variability in the area.

On the demand side, barley price plays a more significant role (t-statistic equal to 1.3), however, income is suggested to be the most significant factor explaining the changes in demand. These variables, along with wheat price and two weather related dummy variables, explain no more than 75 percent of variations in total use in equation (55). Barley prices in Australia seem to show more response to the world price, as compared with Canada. The transmission elasticity (equation 56) in this case is equal to 1.2. This is due to relatively less protection in Australia.

Thailand Submodel

Corn and sorghum in the model have been aggregated since sorghum is not yet as significant as corn, despite its relevance as an export crop.

Table 4.5. The estimated model of the Australian feed grain sector

Equation	R^2	D.W.
(53) BAAHHAU = 1000 - 73.9 * DM17172 + 4.9 * LAG(BAPFMAU/CPIAU) - 4.4 * LAG(WHPFMAU/CPIAU) + .59 * LAG(BAAHHAU) t-values: 1000 (1.27); 73.9 (-.27); 4.9 (.63) [.28]; 4.4 (-.69) [-.3]; .59 (3.3)	.64	1.8
(54) BASPRAU = BAAHHAU * BAYIHAU		
(55) BAUDTAU = 735.9 - 6.8 * (BAPFMAU/CPIAU) + 3.1 * (WHPFMAU/CPIAU) - 269 * DM175 - 447.5 * DM182 + 9.5 * (NANPGAU/CPIAU) t-values: 735.9 (1.7); 6.8 (-1.3) [-.76]; 3.1 (.81) [.4]; 269 (-.97); 447.5 (-1.8); 9.5 (2.3) [.63]	.75	.2
(56) BAPFMAU = -17.9 + 1.5 * (BAPFMU9 * N1MEUAU) t-values: -17.9 (-1.5); 1.5 (10.1) [1.18]		
(57) BASMNAU = BAUDTAU + BACOTAU - BASPRAU - LAG(BACOTAU)		
(58) FGSMNAU = BASMNAU + SOSMNAU		

<u>Endogenous</u>

BAAHHAU = barley area harvested, 1000 ha, USDA
BAPFMAU = barley producer price, AUS$/MT, FAO
BASPRAU = barley production, 1000 MT, USDA
BASMNAU = barley net imports, 1000 MT, USDA
BAUDTAU = barley domestic use, 1000 MT, USDA
FGSMNAU = feed grain net imports, 1000 MT, USDA

<u>Exogenous</u>

BACOTAU = barley ending stocks, 1000 MT, USDA
BAYIHAU = barley yield, MT/ha, USDA
CPIAU = consumer price index, IMF-IFS
DM182 = dummy variable equal to one for year 1982, zero otherwise

Table 4.5. continued

Equation	R^2	D.W.
DM17172 = dummy variable equal to one for the years 1971 and 1972, zero otherwise		
NANPGAU = Gross National Product, mil. AUS$, IMF-IFS		
NIMEUAU = exchange rate, AUS$/US$, IMF-IFS		
SOSMNAU = sorghum, oats, and corn net imports, 1000 MT, USDA		
WHPFMAU = wheat producer price, AUS$/MT, FAO		

Other competing export crops are: cassava that does not significantly affect the area planted to corn and sorghum (as suggested by equation (59) in Table 4.6), and rice that is suggested to play a significant role (with an elasticity of -0.25). Corn prices in the last period, too, have an impact similar to that of rice. However, it seems that a positive trend overshadows the impact of economic variables in this equation. These variables explain 96 percent of the variations in area.

Equation (61) seems to suggest only income expansion is responsible for growth in demand (elasticity of almost 2.0), whereas prices at this level of consumption do not seem to have a significant impact. Of the variations in total use, 95 percent is explained by the variables included in the equation. Domestic prices in Thailand are suggested to respond significantly to the variations in world price, associated with an elasticity of almost 1.2.

South Africa Submodel

Due to drastic variations in South African feed grain production from year to year, the prices do not seem to be related to the variations in supply (see Table 4.7). This factor, plus lack of valid data on prices and government intervention, were the reasons in favor of only modeling the feed grain net import. Feed grain net imports could, in major part, be determined by the variations in production and the beginning stock on the supply side (elasticities of -2.5 and -0.59, respectively). On the demand side, it is real income that affects demand and, through that, plays a significant role in determination of exports

Table 4.6. The estimated model of the Thailand feed grain sector

Equation	R^2	D.W.
(59) CSAHHTH = -168045 + 85.8 * YEAR - .16	.96	1.9
(-9.5) (9.6) (-.98)		
[-.08]		
* LAG(KVPFMTH/CPITH) + .14		
(1.6)		
[.24]		
* LAG(COPFMTH/CPITH) - .12 * LAG(RIPFMTH/CPITH)		
(-1.6)		
[-.25]		
(60) CSSPRTH = CSAHHTH * CSYIHTH		
(61) CSUDTTH = -594.6 + 2.2 * (NANPDTH/CPITH) + 1.2	.95	2.7
(-3.4) (3.3) (1.1)		
[1.9] [.36]		
* CPILVTH - 23.6 * (COPFMTH/KVPFMTH)		
(-1.03)		
[-.13]		
(62) COPFMTH = -240.5 + 1.02 * (COPFMU9 * N1MEUTH)	.86	1.1
(-1.1) (8.6)		
[1.16]		
(63) CSSMNTH = CSUDTTH + CSCOTTH - CSSPRTH - LAG(CSCOTTH)		
(64) FGSMNTH = CSSMNTH + OBSMNTH		

Endogenous

COPFMTH = corn producer price, baht/MT, FAO
CSAHHTH = corn and sorghum area harvested, 1000 ha, USDA
CSSMNTH = corn and sorghum net imports, 1000 MT, USDA
CSSPRTH = corn and sorghum production, 1000 MT, USDA
CSUDTTH = corn and sorghum total domestic use, 1000 MT, USDA
FGSMNTH = feed grain net imports, 1000 MT, USDA

Exogenous

CPILVTH = livestock product price index, FAO
CPITH = consumer price index, IMF-IFS
CSCOTTH = corn and sorghum ending stock, 1000 MT, USDA
CSUDTTH = corn and sorghum total domestic use, 1000 MT, USDA
CSYIHTH = corn and sorghum yield, MT/ha, USDA

Table 4.6. continued

Equation	R^2	D.W.
KVPFMTH = cassava producer price, baht/MT, FAO		
NANPDTH = GNP, purchase value, bill baht, IMF-IFS		
NIMEUTH = exchange rate, baht/US$, IMF-IFS		
OBSMNTH = oats and barley net imports, 1000 MT, USDA		
RIPFMTH = paddy rice producer price, baht/MT, FAO		

Table 4.7. The estimated model of the South African feed grain sector

Equation	R^2	D.W.
(65) FGSMNZA = 880.7 - .65 * FGSPRZA - .87 * LAG(FGCOTZA)	.98	2.7
(1.4) (-18.3) (-2.9)		
[-2.5] [-.59]		
+ .09 * (NANPGZA/CPIZA)		
(4.4)		
[1.86]		
<u>Endogenous</u>		
FGSMNZA = feed grain net imports, 1000 MT, USDA		
<u>Exogenous</u>		
CPIZA = consumer price index, IMF-IFS		
FGCOTZA = feed grain ending stocks, 1000 MT, USDA		
FGSPRZA = feed grain production, 1000 MT, USDA		
NANPGZA = nominal GNP, mil. of Rand, IMF-IFS		

(elasticity of almost 2). These variables explain 98 percent of variations in the net import.

Japan Submodel

Japanese production of corn and sorghum has been exogenized in this model, since it is very insignificant. Furthermore, corn and sorghum have been aggregated. Domestic rice fed in Japan is suggested (equation 66 in Table 4.8) to be a significant substitute for corn and sorghum in total use. Soymeal and corn prices are both significant with respective elasticities of 0.16 and .2. Livestock production is suggested to be the most significant determinant of total use. These variables explain 96 percent of variations in total use. Government stock management in Japan does affect the prices, in response to grain and livestock price levels. The real corn price, sorghum price, and livestock retail price, then, enter the stock equation. None of these variables, however, are suggested by equation (67) to be of significance. The beginning stock is not significant either. The R-square related to this equation is poor, as well. Although the price transmission elasticity indicates a perfect response and a nonprotected market (equation 68), only 76 percent of the variability in domestic prices is explained by the changes in the world price level.

Soviet Submodel

Due to the planned nature and the unknown parameters of the Soviet production of grain, this study only focuses on the Soviet consumption

Table 4.8. The estimated model of the Japanese feed grain sector

Equation	R^2	D.W.
(66) SCUDTJP = -3166.5 - 1.9 * RIUFEJP + .02	.96	2.1
(-.86) (-3.4) (1.65)		
[-.1] [.16]		
* (SMPWHJP/WPIJP) - .06 * (COPWHJP/WPIJP)		
(-2.1)		
[-.2]		
+ .86 * LVCACJP		
(7.9)		
[1.4]		
(67) SCCOTJP = -600.1 - .42 * LAG(SCCOTJP) - .03	.59	2.3
(-.15) (-.26) (-.46)		
[-2.6]		
* (SGPFMJP/WPIJP) + 7.8 * LAG(LVPREJP) - .03		
(.63) (-.59)		
[2.5] [-1.05]		
* LAG(COPWHJP/WPIJP) - 982.9 * DM18182		
(68) COPWHJP = -1466 + 1.42 * (COPFMU9 * N1MEUJP)	.76	2.2
(-.26) (5.9)		
[1.1]		
(69) SCSMNJP = SCUDTJP + SCCOTJP - SCSPRJP - LAG(SCCOTJP)		
(70) FGSMNJP = SCSMNJP + OBSMNJP.		

<u>Endogenous</u>

COPWHJP = corn wholesale imported price, yen/MT, Feed Monthly
FGSMNJP = feed grain net imports, 1000 MT, USDA
SCCOTJP = sorghum and corn ending stocks, 1000 MT, USDA
SCSMNJP = corn and sorghum net imports, 1000 MT, USDA
SCUDTJP = corn and sorghum total domestic use, 1000 MT, USDA

<u>Exogenous</u>

DM1812 = dummy variable equal to one in 1981 and 1982, zero otherwise
LVCACJP = grain consuming animal units, 1000 head
LVPREJP = livestock retail price, calculated from MERC
NIMEUJP = exchange rate, yen/US$, IMF-IFS
RIUFEJP = rice feed use, 1000 MT, USDA
SGPFMJP = sorghum producer price, peso/MT, USDA
SMPWHJP = wholesale soymeal price, yen/MT, Feed Monthly
WPIJP = wholesale price index, IMF-IFS

which is of major importance to the world market. Since the planned consumption should be met by planned production, and since it is the area planted that is under the control of the planners, the latter variable enters the demand function. This variable is significant, and its unitary elasticity is further illustrative of the planned response. On the other hand, the adverse changes in the feed grain yield forces the Soviet government to fill the gap between supply and demand by importing from other countries. Therefore, yield enters the total use equation (equation 71, Table 4.9). This variable is also significant and is associated with an elasticity of 0.6. Since part of the Soviet imports are financed by gold exports, then Soviet response to world market prices will be in its relation to the gold price in the international market. This is the only price response included in the Soviet model, since the domestic consumer price level has not changed for over a decade. The above ratio is suggested to be significant, however, the elasticity associated with it is only 0.07.

Spain Submodel

For this region, all the feed grains have been aggregated, but only the barley price has been used as a proxy for the feed grain prices. This is due to the major significance of barley in feed grain production and consumption. Moreover, policy prices of other feed grains are set to follow the policy prices for barley. Policy makers affect the barley area by changing the ratio of barley to wheat policy prices. Hence, wheat price enters the equation to determine the feed grain area

Table 4.9. The estimated model of the Soviet feed grain sector

Equation	R^2	D.W.
(71) FGUDTSU = -35528.9 - 12308.7 * (COPFMU9/GOLDPUK)	.97	2.5
(-2.55) (-2.67)		
[-.07]		
+ 1.77 * FGAHHSU + 28560 * FGYIHSU		
(6.2) (5.1)		
[.98] [.58]		
(72) FGSMNSU = FGUDTSU + FGCOTSU - FGAHHSU * FGYIHSU		
- LAG(FGCOTSU)		

Endogenous

FGSMNSU = feed grain, net import, 1000 MT, USDA
FGUDTSU = feed grain, total use, 1000 MT, USDA

Exogenous

FGAHHSU = feed grain, harvested area, 1000 ha, USDA
FGCOTSU = feed grain, ending stock, 1000 MT, USDA
FGYIHSU = feed grain, yield, MT/ha, USDA
GOLDPUK = London gold price index, IMF-IFS

harvested. It has a significant coefficient and unitary elasticity. However, barley price itself does not turn out to be significant in the supply equation (equation 73, Table 4.10). There seems to be a positive trend in area harvested. These variables explain 96 percent of variations in feed grain area harvested.

Real price seems to be more significant in explaining the changes in consumption, as compared to its significance in production. Nevertheless, it is income growth that is the most important factor in explaining the growth in demand. These two variables explain 95 percent of variations in total use. Elasticity of transmission, as suggested by equation (76), for domestic and world price is 0.75, which is indicative of some degrees of market intervention as explained previously.

Validation of the Model

This section intends to examine the validity of the model for simulating the actual functions. A combination of different measures is used to evaluate the performance of the model.

The validity of an econometric model should be investigated in two dimensions -- economic and statistic. The signs of the coefficients, in almost all cases, are responding to the a priori expectations, as guided by the economic theory. The sizes of the coefficients are reasonable as well. As for the elasticities, one can question their size, in some cases, but on the other hand, a diverse range of elasticities could be observed when going through different models. Average elasticities could

Table 4.10. The estimated model of the Spanish feed grain sector

Equation	R^2	D.W.
(73) FGAHHES = 175184 + .02 * LAG(BAPFMES/CPIES) - .21	.96	1.6
(1.5) (.69) (-4.3)		
[.007] [-1.04]		
* LAG(WHPFMES/CPIES) - 4.5 * YEAR		
(-1.4)		
(74) FGSPRES = FGAHHES * FGYIHES		
(75) FGUDTES = -248 - .14 * (BAPFMES/CPIES) + 1136	.95	2.4
(-.05) (-1.2) (5.4)		
[-.18] [1.3]		
* (NANPGES/CPIES)		
(76) BAPFMES = 1813 + 1.06 * (BAPFMU9 * N1MEUES)	.91	.7
(2.4) (10.8)		
[.75]		
(77) FGSMNES = FGUDTES + FGCOTES - FGSPRES - LAG(FGCOTES)		

Endogenous

- BAPFMES = barley, producer price, peseta/MT, FAO
- FGAHHES = feed grain, area harvested, 1000 ha, USDA
- FGSMNES = feed grain, net import, 1000 MT, USDA
- FGSPRES = feed grain, production, 1000 MT, USDA
- FGUDTES = feed grain, total use, 1000 MT, USDA

Exogenous

- CPIES = consumer price index, IMF-IFS
- FGYIHES = feed grain, yield, MT/ha, USDA
- FGCOTES = feed grain ending stock, 1000 MT, USDA
- NANAPGES = nominal GNP, million peseta, IMF-IFS
- SBSMNES = sorghum, barley and oats, net imports, 1000 MT, USDA
- WHPFMES = wheat producer price, peseta/MT, FAO

be very different, depending on the period of study. Point elasticities are more comparable, but require much more work and space to report.

Statistically, the validity of the model could be approximated by some measures, among which are the validity of the parameters estimated and the ability of the model to reproduce the actual data, in a dynamic simulation. Most of the coefficients, as displayed in the last section, are statistically significant. All but one of the behavioral equations are either not proven to have a significant correlation, or have a Durbin-Watson value which falls in the indeterminate portion of the test. The DW test for the EC wheat price transmission equation fails to reject the hypothesis of nonautocorrelated disturbances in favor of positive autocorrelation. This equation, however, is not of vital relevance to the study. The R-squares are generally at a high level except for a few equations, as specified in the last section.

The statistics utilized to evaluate the model's performance in this study are the RMS error, RMS percentage error, and the Theil statistics. These statistics are calculated by comparing the historical simulation and the actual data over the observation period of 1968-1982. RMS error measures average deviation of the simulated values from actual values, as shown in the following formula:

$$RMS = \sqrt{\frac{1}{n} \sum_{t=1}^{n} (\hat{y}_t - y_t)^2}$$

where $\hat{y}_t$ is the simulated value of the endogenous variable at period t, and y_t is its actual value. n is the number of observations. Since RMS depends on the size of the variable, percent RMS is calculated to make it possible to compare the goodness of different equations. It is defined as follows:

$$\text{RMS percent error} = \sqrt{\frac{1}{n}\sum_{t=1}^{n}\left(\frac{\hat{y}_t - y_t}{y_t}\right)^2}$$

Table 4.11 reports the statistics of fit related to this model. Theil's inequality coefficient is another simulation statistic, related to RMS simulation error, that is useful to evaluate the historical simulation. It is defined (Maddala, 1977) as a statistic measuring the accuracy of simulation by:

$$U = \frac{\sqrt{\frac{1}{n}\sum_{t=1}^{n}(\hat{y}_t - y_t)^2}}{\sqrt{\frac{1}{n}\sum_{t=1}^{n}(\hat{y}_t)^2} + \sqrt{\frac{1}{n}\sum_{t=1}^{n}(y_t)^2}}$$

U will always fall between 0, the perfect fit situation, and 1, the worst possible fit. The numerator or the RMS error could be decomposed into three components as follows:

$$MSE = \frac{1}{n}\Sigma(\hat{y}_t - y_t)^2 = (\hat{y}_t - y_t)^2 + (\partial\hat{y}_t - \rho\partial y_t)^2 + (1-\rho)^2\, \partial\hat{y}_t\partial y_t$$

where $\rho = \frac{1}{n}\left(\frac{\Sigma(\hat{y}_t - \bar{\hat{y}})(y_t - \bar{y})}{\partial\hat{y}_t\partial y_t}\right)$ or the correlation coefficient. The

Table 4.11. Statistics of fit for the world feed grain model

Variable	RMS error	RMS % error
FGAHHES	104.746	0.0249769
SCCOTJP	224.026	0.184532
FGSMNZA	277.034	0.469069
CSAHHTH	73.5446	0.0577616
BAAHHAU	258.665	0.124713
COAHHCA	58.0289	0.0805752
BAAHHCA	659.618	0.144815
SGAHHAR	176.791	0.0872691
COAHHAR	214.537	0.0760001
COAPHU9	730.206	0.0237073
COPTHEO	8.60475	0.0445815
WOPIMEO	17.6596	0.167711
CSSPRTH	155.899	0.0577616
BASPRAU	324.768	0.124713
COSPRCA	320.86	0.0805752
BASPRCA	1390.2	0.144815
SGSPRAR	504.834	0.0872691
COSPRAR	582.308	0.0760001
COYIHU9	0.180733	0.0314325
COAHHU9	761.612	0.0281013
BAPTHEO	6.41063	0.0394119
WOPTHEO	15.7623	0.0575121
COYIHEO	0.224521	0.0453179
COUFEEO	1106.57	0.0536503
COUHTEO	459.2	0.0885666
COSPRU9	5265.83	0.0305128
WHYIHEO	0.178116	0.049923
BAAHHEO	173.36	0.0181899
BAUHTEO	456.44	0.0536734
BAUFEEO	385.209	0.0148554
COSPREO	675.553	0.0453179
WHSPREO	2105.96	0.049923
BASPREO	687.273	0.0181899
WHUFEEO	547.906	0.0483366
COSMNEO	1342.45	0.139775
BASMNEO	959.941	5.21201
WHSMNEO	4583.03	1.64315
SMUFEEO	1048.75	0.108814
SMSMNEO	1013.85	0.298689
FGSMNEO	1328.95	0.130922
FGUDTSU	2443.46	0.0318529
BAPOBCA	17.6418	0.168259
COUFEU9	2920.04	0.0283218
SGPFMAR	185379441	0.158368
COSMNAR	527.666	0.111251
COCOTU9	5080.4	0.270179

Table 4.11. continued

Variable	RMS error	RMS % error
FGSMNSU	2443.46	1.86075
COUDTAR	228.927	0.0701241
SGPFMU9	8.33106	0.104537
SGUDTAR	206.465	0.085449
COPFMAR	385675647	0.135442
BAPFMU9	11.4778	0.136689
FGSMNAR	579.007	0.0686509
CSUDITH	85.2065	0.146356
COPFMTH	242.795	0.167921
CSSMNTH	163.245	0.070896
FGSMNTH	163.245	0.070896
COUHTU9	1232.76	0.0867684
FGSMNAU	333.903	0.167506
COPFMU9	10.3392	0.114342
COPWHJP	4560.67	0.159259
SCSMNJP	674.917	0.0610918
FGSMNJP	674.917	0.0545089
BAPFMES	1533.28	0.165961
BAUDTAU	198.575	0.184644
FGUDTES	465.182	0.0361425
BASMNAU	333.903	0.294569
COSMNU9	2943.55	0.117198
FGSMNES	1015.57	0.271289
SGSMNAR	541.634	0.24536
CBUDTCA	465.963	0.0414269
FGSMNU9	2943.55	0.0959026
SCUDTJP	617.542	0.0566259
FGSMNCA	1662.37	0.708831
CBSMNCA	1662.37	0.715961
BAPFMAU	14.3364	0.170167
COPFMCA	11.959	0.120472
COPIMEO	12.597	0.0916796
BAPIMEO	18.9979	0.153786

proportions of the inequality, as defined in Pindyk and Rubinfeld (1981), then, are as follows:

$$UM = \frac{(\bar{\hat{y}}-\bar{y})^2}{MSE},$$

$$UD = \frac{(\partial\hat{y}_t-\rho\partial y_t)^2}{MSE},$$

$$UR = \frac{(1-\rho^2)\ \partial\hat{y}_t\partial y_t}{MSE}.$$

UM, UD, and UR will be referred to as bias, disturbance, and regression errors. It should be noted that UM + UD + UR = 1. High values of UM and UD create enough concern to consider the revision of the model. Table 4.12 reports the Theil's forecast error measures.

Most endogenous variables have reasonable RMS percent error (Table 4.11) that is less than 0.2. Out of 80 endogenous variables, only ten have RMS percent errors above 0.2. These variables are: WHSMNEO, BASMNEO, SMSMNEO, FGSMNEO, BASMNAU, FGSMNES, CBSMNCA, FGSMNCA, FGSMNZA, and FGSMNSU. These variables are all the net imports, calculated as the difference between demand and supply, components of which are all the other endogenous variables determined by the model for each region. Therefore, the error in the net import variables are resulted from simulation error in all of the endogenous variables that enter the particular net import identity. For example, in the case of the Soviet Union the RMS error in the feed grain net import is identical to the RMS

Table 4.12. Theil's forecast error measures for the world feed grain model

Variable	Relative change MSE	Decomposition Bias (UM)	regress. (UR)	disturb. (UD)	Accuracy (U1)
FGAHHES	0.000662955	0.01	0.60	0.39	0.0000
SCCOTJP	0.0581637	0.00	0.41	0.59	0.0002
FGSMNZA	0.00918813	0.02	0.11	0.88	0.0000
CSAHHTH	0.00383792	0.00	0.04	0.95	0.0000
BAAHHAU	0.0160973	0.06	0.24	0.70	0.0001
COAHHCA	0.0078005	0.00	0.49	0.51	0.0001
BAAHHCA	0.0203355	0.01	0.48	0.51	0.0000
SGAHHAR	0.00754215	0.01	0.19	0.80	0.0000
COAHHAR	0.00487185	0.00	0.01	0.99	0.0000
COAPHU9	0.000584514	0.00	0.03	0.97	0.0000
COPTHEO	0.00208946	0.10	0.39	0.50	0.0002
WOPIMEO	0.0212163	0.00	0.00	1.00	0.0012
CSSPRTH	0.00805958	0.02	0.35	0.64	0.0000
BASPRAU	0.0222685	0.06	0.13	0.82	0.0001
COSPRCA	0.00854058	0.00	0.23	0.77	0.0000
BASPRCA	0.0180034	0.01	0.41	0.58	0.0000
SGSPRAR	0.00909602	0.03	0.31	0.67	0.0000
COSPRAR	0.00609286	0.00	0.01	0.99	0.0000
COYIHU9	0.00105764	0.00	0.01	0.98	0.0055
COAHHU9	0.000868795	0.00	0.15	0.85	0.0000
BAPTHEO	0.00166901	0.01	0.50	0.49	0.0002
WOPTHEO	0.00366083	0.10	0.50	0.40	0.0003
COYIHEO	0.00196442	0.00	0.02	0.98	0.0082
COUFEEO	0.00261283	0.05	0.23	0.72	0.0000
COUHTEO	0.00992866	0.00	0.29	0.71	0.0000
COSPRU9	0.0010499	0.00	0.07	0.93	0.0000
WHYIHEO	0.00265762	0.00	0.40	0.60	0.0135
BAAHHEO	0.000325405	0.00	0.03	0.97	0.0000
BAUHTEO	0.00314706	0.00	0.41	0.59	0.0000
BAUFEEO	0.000224604	0.00	0.06	0.94	0.0000
COSPREO	0.00202783	0.00	0.15	0.85	0.0000
WHSPREO	0.00260164	0.00	0.05	0.95	0.0000
BASPREO	0.000338832	0.00	0.14	0.86	0.0000
WHUFEEO	0.00256557	0.21	0.14	0.65	0.0000
COSMNEO	0.0150402	0.03	0.21	0.75	0.0000
BASMNEO	17.4858	0.08	0.72	0.20	0.0018
WHSMNEO	5.57141	0.16	0.03	0.81	0.0003
SMUFEEO	0.013863	0.16	0.27	0.57	0.0000
SMSMNEO	0.0979814	0.12	0.71	0.17	0.0001
FGSMNEO	0.0119265	0.07	0.13	0.80	0.0000
FGUDTSU	0.001138	0.00	0.05	0.95	0.0000
BAPOBCA	0.0293152	0.02	0.23	0.75	0.0016

Table 4.12. continued

Variable	Relative change MSE	Decomposition			Accuracy (U1)
		Bias (UM)	regress. (UR)	disturb. (UD)	
COUFEU9	0.000870842	0.01	0.02	0.97	0.0000
SGPFMAR	0.199611	0.02	0.15	0.83	0.0000
COSMNAR	0.0152152	0.00	0.01	0.99	0.0000
COCOTU9	0.0155246	0.04	0.03	0.93	0.0000
FGSMNSU	6.75694	0.03	0.42	0.55	0.0002
COUDTAR	0.0044066	0.01	0.32	0.67	0.0000
SGPFMU9	0.0114114	0.00	0.33	0.67	0.0013
SGUDTAR	0.00875656	0.00	0.11	0.89	0.0000
COPFMAR	0.285821	0.01	0.11	0.89	0.0000
BAPFMU9	0.0194675	0.01	0.31	0.68	0.0014
FGSMNAR	0.00487911	0.01	0.03	0.96	0.0000
CSUDTTH	0.0246542	0.03	0.02	0.95	0.0002
COPFMTH	0.0368086	0.06	0.68	0.26	0.0001
CSSMNTH	0.0119672	0.02	0.31	0.67	0.0000
FGSMNTH	0.0119672	0.02	0.31	0.67	0.0000
COUHTU9	0.00860921	0.00	0.74	0.26	0.0000
FGSMNAU	0.0293636	0.15	0.16	0.68	0.0001
COPFMU9	0.0134055	0.02	0.18	0.80	0.0013
COPWHJP	0.0214337	0.03	0.35	0.62	0.0000
SCSMNJP	0.00433752	0.00	0.07	0.92	0.0000
FGSMNJP	0.00350728	0.00	0.08	0.92	0.0000
BAPFMES	0.0351344	0.04	0.81	0.15	0.0000
BAUDTAU	0.0386304	0.00	0.36	0.64	0.0002
FGUDTES	0.00149584	0.05	0.03	0.93	0.0000
BASMNAU	0.113887	0.15	0.34	0.51	0.0002
COSMNU9	0.0156624	0.02	0.19	0.79	0.0000
FGSMNES	0.0584101	0.01	0.14	0.86	0.0001
SGSMNAR	0.0326799	0.05	0.17	0.78	0.0001
CBUDTCA	0.00181009	0.00	0.02	0.98	0.0000
FGSMNU9	0.010632	0.02	0.17	0.81	0.0000
SCUDTJP	0.00363115	0.00	0.20	0.80	0.0000
FGSMNCA	1.30503	0.03	0.65	0.32	0.0003
CBSMNCA	1.22805	0.02	0.70	0.28	0.0003
BAPFMAU	0.0319902	0.04	0.63	0.33	0.0018
COPFMCA	0.0142871	0.00	0.01	0.98	0.0012
COPIMEO	0.0104592	0.00	0.00	0.99	0.0009
BAPIMEO	0.0328264	0.27	0.01	0.73	0.0016

error in the total use (2.4 MT). However, the RMS percent error for total use and net imports are quite different (0.03 and 1.9, respectively) since the size of total use is significantly higher than net import. None of the behavioral equations have RMS percent errors higher than 0.2.

The situation could be better understood by going through Theil's forecast error measures (Table 4.12). The most significant bias is observed in the EC barley price (BAPIMEO) transmission equation, which is equal to 0.27. This variable has no relation to any other variable in the model and it is only used in one of the scenarios. Therefore, it does not create significant trouble for the model. Some of the equations for which high regression errors are reported are the same as those having a high RMS percent error, as explained before. Most of the other equations that have a relatively higher regression error are the price transmission equations. The rest include area equations for Canada and Spain. Also, the U.S. food use (COUHTU9) equation does not seem to perform well in a simultaneous equation, as judged by the regression error.

A further measure to evaluate the validity of the model is to see how well the model simulates the turning points. One way to examine that is to look at the graphic presentation of simulated versus actual values, over the estimation period. Since the model has numerous endogenous variables, only four key variables have been chosen to visualize the performance of the model with regards to the turning points (Figures 4.1 to 4.13). In this respect, the model performs well.

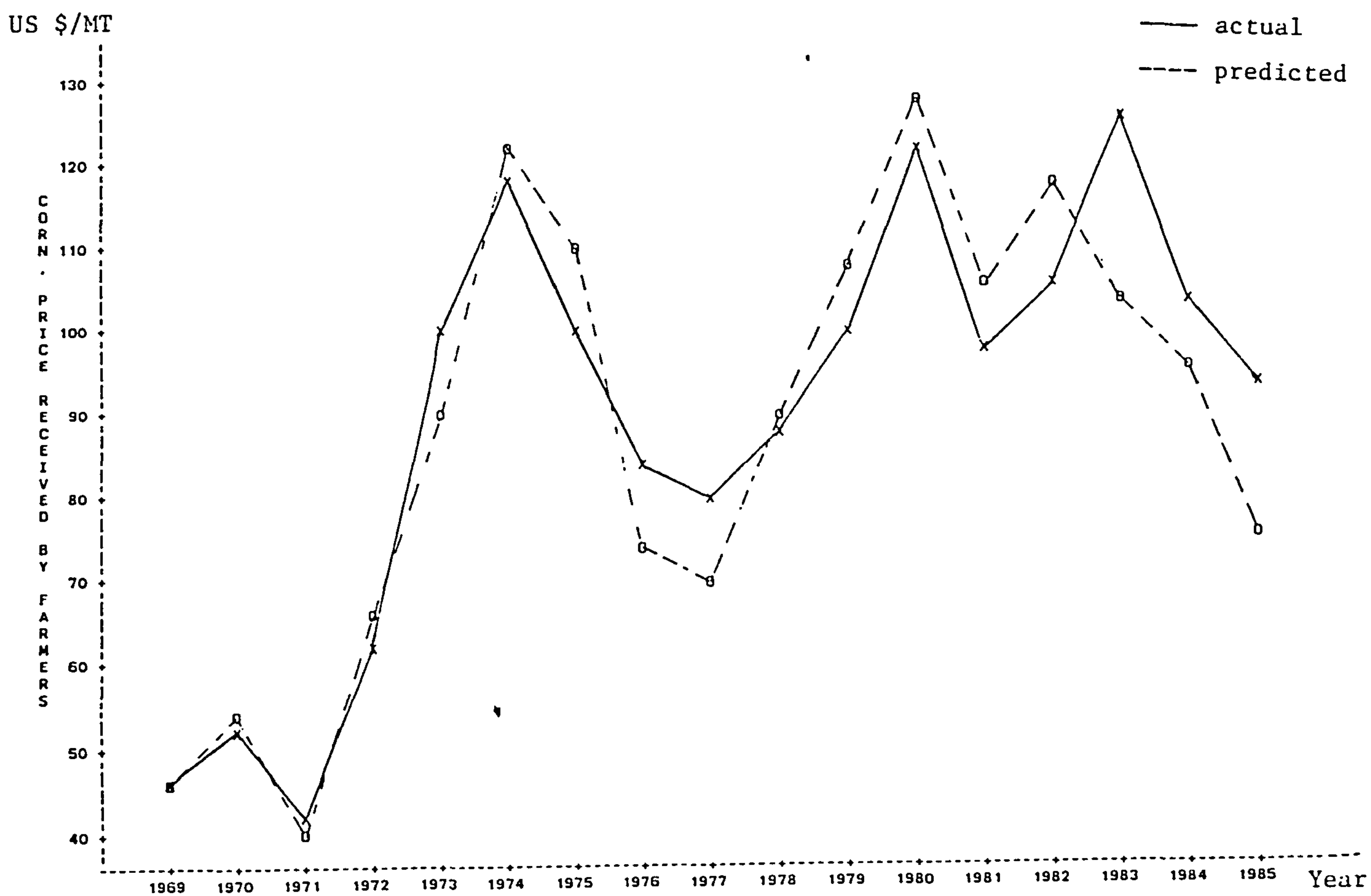


Figure 4.1. Actual and predicted values of US corn (world) price

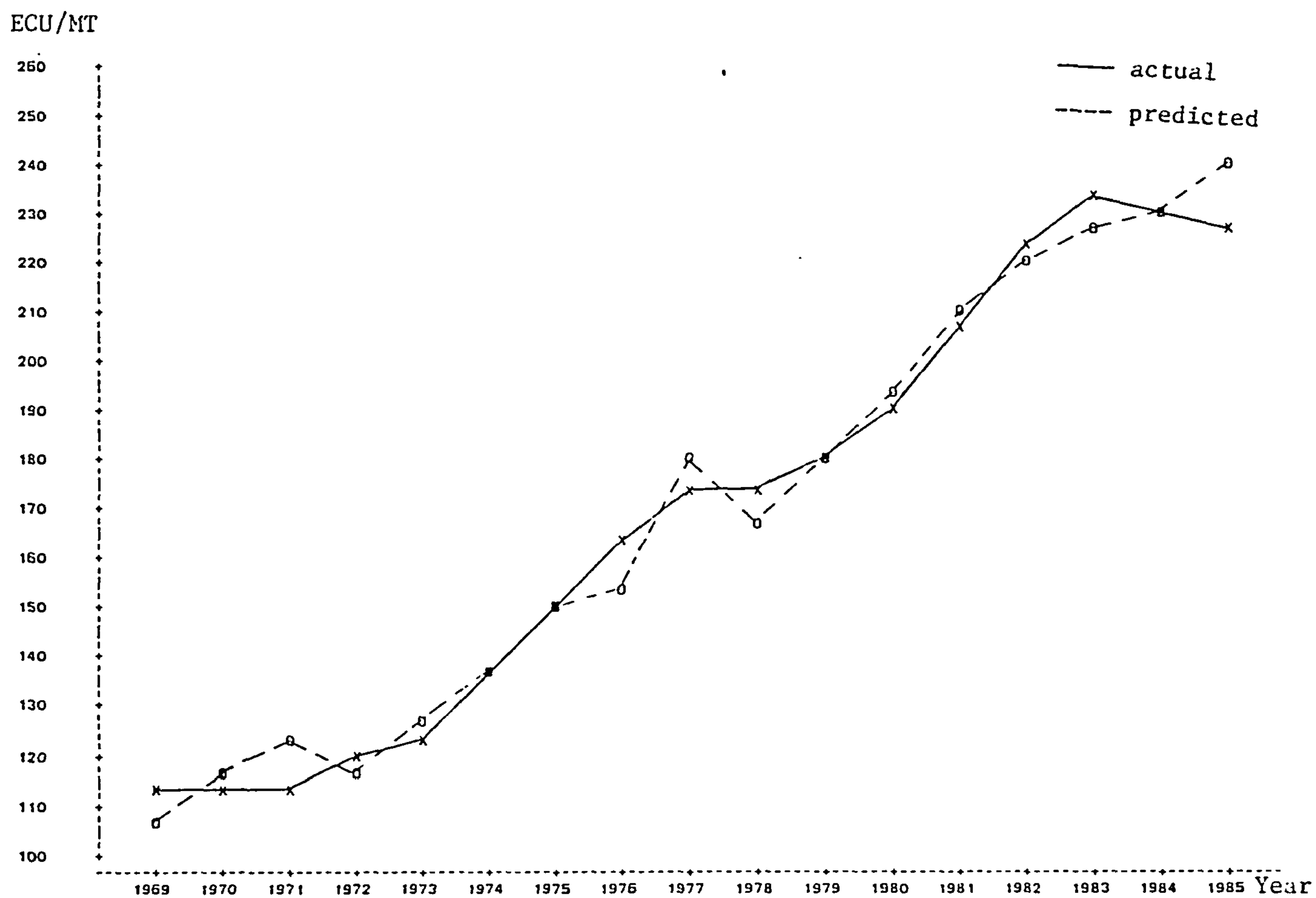


Figure 4.2. Actual and predicted values of EC corn threshold price

Figure 4.3. Actual and predicted values of EC net corn imports

Figure 4.4. Actual and predicted values of EC net barley imports

Figure 4.5. Actual and predicted values of United States net feed grain imports

Figure 4.6. Actual and predicted values of Argentine net feed grain imports

Figure 4.7. Actual and predicted values of Canadian net feed grain imports

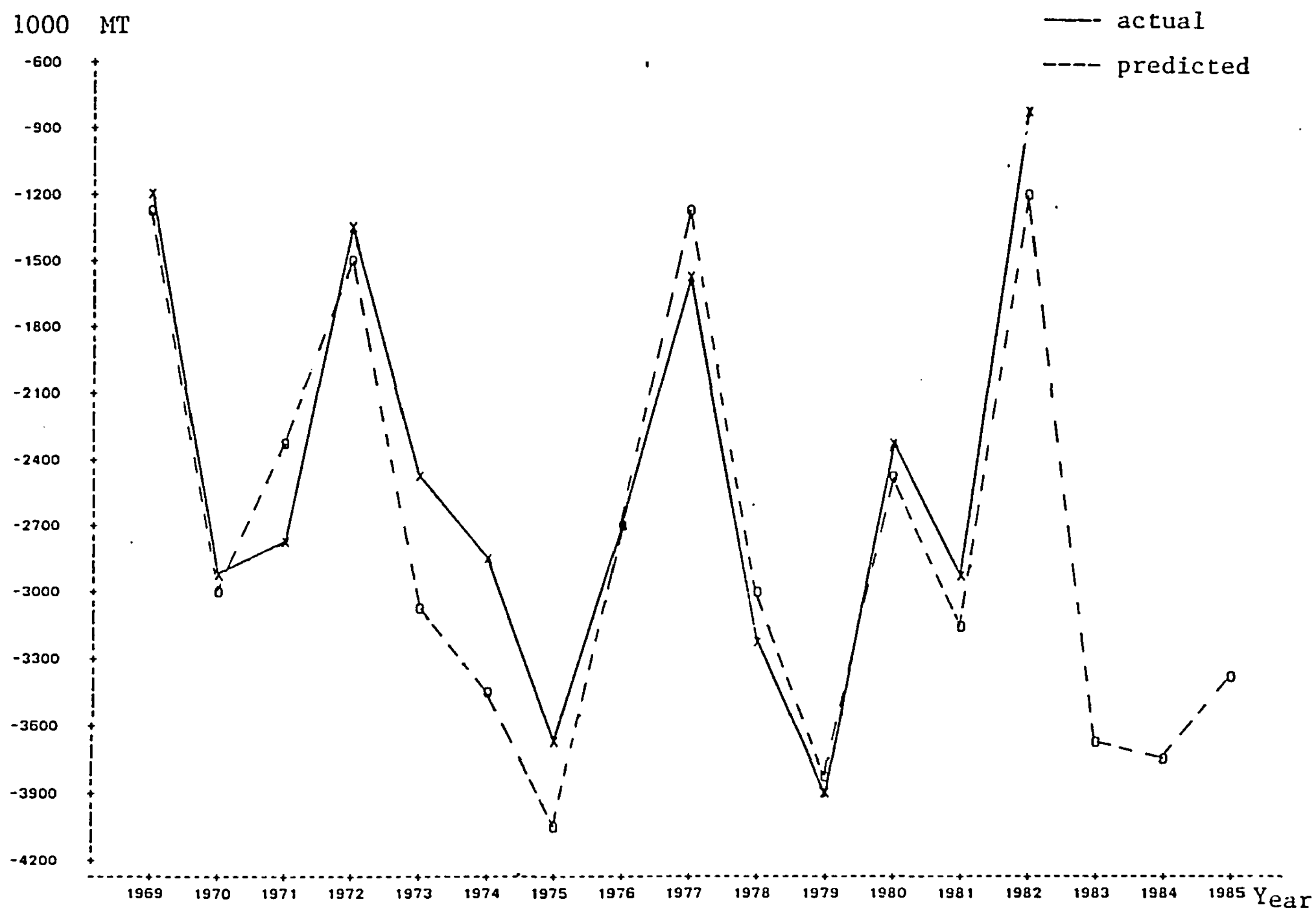


Figure 4.8. Actual and predicted values of Australian net feed grain imports

Figure 4.9. Actual and predicted values of Thailand net feed grain imports

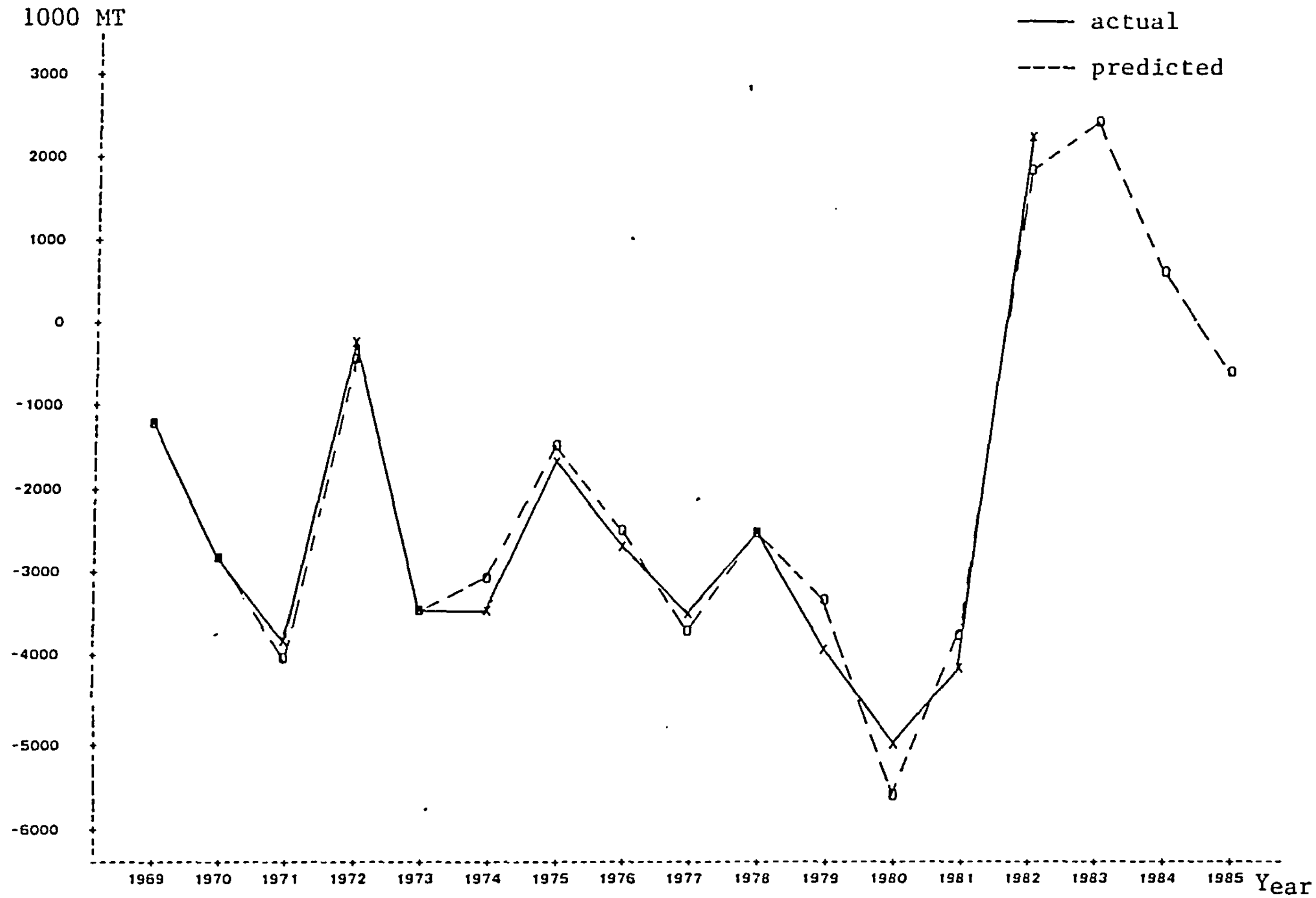


Figure 4.10. Actual and predicted values of South African net feed grain imports

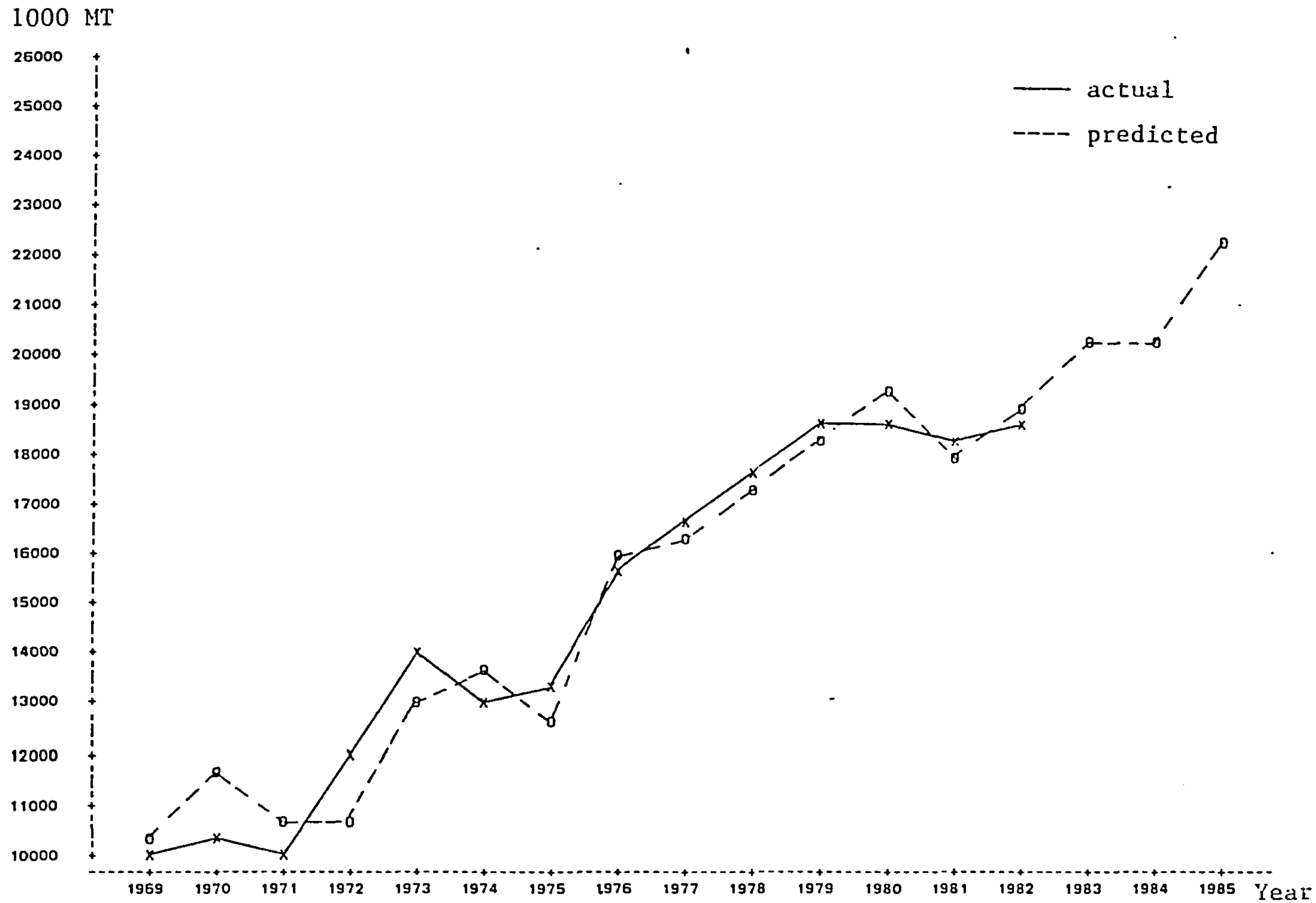


Figure 4.11. Actual and predicted values of Japan net feed grain import

Figure 4.12. Actual and predicted values of USSR net feed grain imports

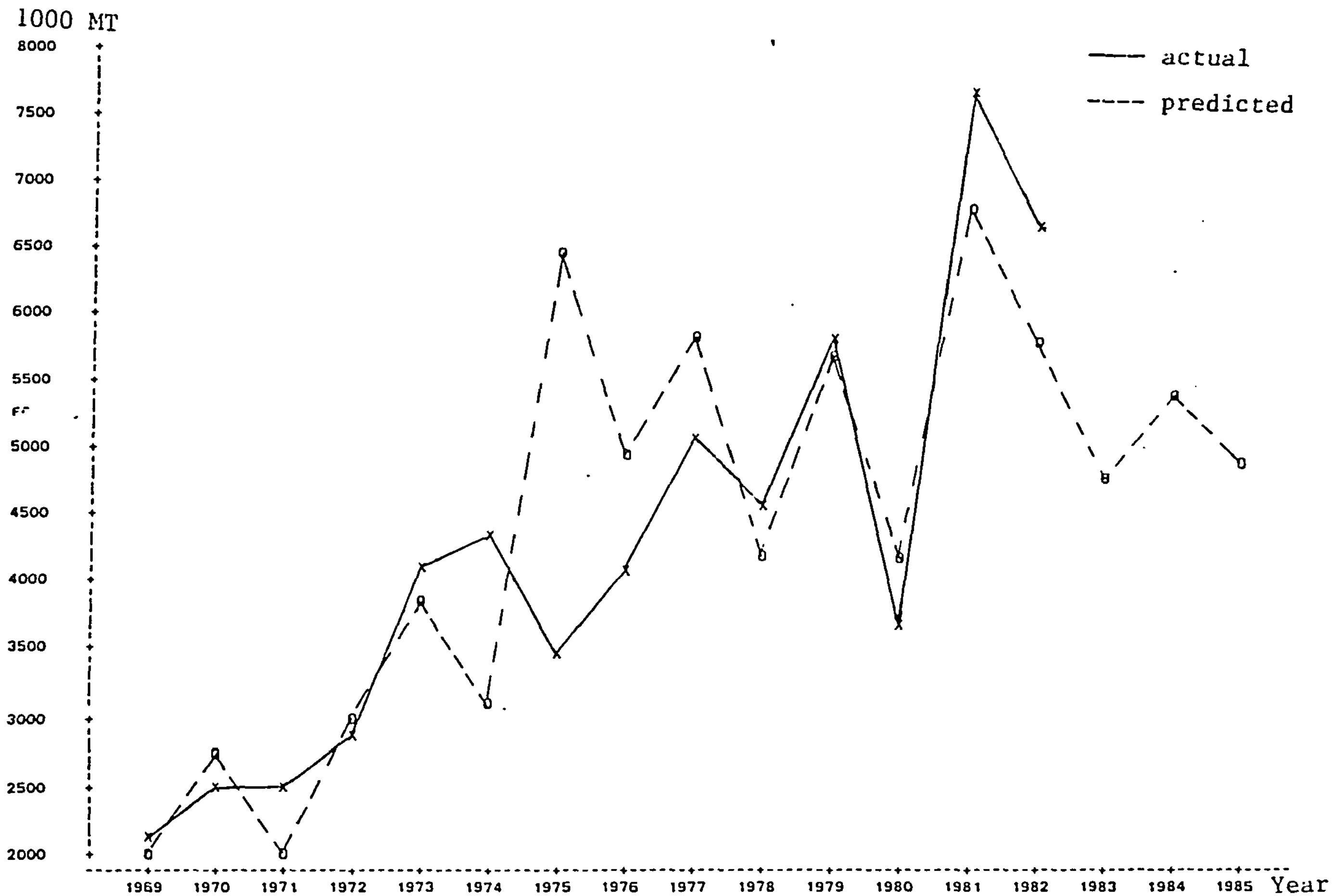


Figure 4.13. Actual and predicted values of Spain net feed grain imports

CHAPTER V. SIMULATION OF POLICY SCENARIOS

Pressures for changes in the EC common agricultural policies have been building for several years, and from different directions. There are external pressures, originating from countries which have lost their export market, because of the policies followed by the EC. And, there are internal pressures, due to the increasing costs of the protective policies. External forces (i.e., other grain exporting countries led by the U.S.) have been pushing for the total dismantling of the present protective policies in the grain sector and, hence, for the overnight liberalization of the EC agricultural markets. While such a solution is highly unrealistic, there also exist problems in dealing with simulating such a scenario. Overnight liberalization brings such a drastic change, that will cause a significant change in the behavioral relationships in the model, i.e., in the market structure. Therefore, it may no longer be appropriate to use the model (estimated over the protective period) in order to study the impact of this drastic change. This point is further discussed in Bahreinian and Meyers (1986). Moreover, these outside forces have not been successful, for different reasons, among which is the domestic policy making dynamics that does not favor such an action.

Budget pressure has been building for some years now and has been the effective force in the direction of reform. It calls for modifications in the policy prices, none of which could be considered a drastic measure. On the other hand, European producers have been arguing in favor of some sort of import tax for the oilseed products, and some kind of barriers for other grain substitutes, such as: manioc, corn glutten, etc. Some restrictions are already in effect for manioc and corn glutten.

The scenarios chosen in this study are those believed to be more realistic and those more favored by the producers. These are the modification of the price scheme, imposition of some sort of tax on soymeal imports, and granting producer subsidy rather than insulating the market. Each of these policies will be examined in terms of their impact on the EC, and on the other world market participants. All the policy changes are simulated to happen on and after the 1986-87 crop year.

The base scenario used to evaluate the historical performance of the model-generates forecasts that imply the policies of the 1970s are followed, unaltered, in the second half of the 1980s, as well. This characteristic could be attributed to the period in which the model is estimated (1968-1982). But, actually the policies of the 1970s have been modified in the 1980s, due to political and economic factors not accounted for in the model. The EC policy prices during 1983-1986, and those proposed by EC policy makers for the following years, resemble the scenario of constant nominal policy price. Therefore, the constant nominal price scenario has been chosen as the base with which the forecasts generated by other scenarios are compared. The change in the level of each of the endogenous variables is called policy impact. The relation between the change in the level of each variable and the level of the endogenous variable in the base scenario gives the percentage change in that variable due to the change in policy (Tables 5.1-5.6).

Table 5.1. Price modification scenario, impact on the net trade and price of the EC and other regions

Variable	Year	Base[d] (1000 MT)	Simulation #1[a] Change (1000 MT)	Simulation #1[a] % change	Simulation #2[b] Change (1000 MT)	Simulation #2[b] % change	Simulation #3[c] Change (1000 MT)	Simulation #3[c] % change
Corn threshold price (EC)	1986	235	6	2.5	18	7.7	-6	-2.5
	1987	235	14	5.9	29	12.3	-17	-7.2
	1988	235	21	8.9	40	17.0	-28	-11.9
	1989	235	28	11.9	51	21.7	-39	-16.6
	Average	235	17	7.2	34	14.5	-23	-9.8
Corn net imports (EC)	1986	7084	-188	-2.6	-553	-7.8	180	2.5
	1987	5515	-413	-7.5	-852	-15.4	510	9.2
	1988	5077	-593	-11.7	-1132	-22.3	801	15.7
	1989	4672	-763	-16.3	-1393	-29.8	1060	22.7
	Average	5587	-492	-8.8	-981	-17.6	638	11.4
Barley net exports (EC)	1986	9089	372	4.0	1095	12.0	-356	-3.9
	1987	9307	840	9.0	1731	18.6	-1035	-11.1
	1988	9530	1233	12.9	2352	24.7	-1666	-17.5
	1989	9756	1623	16.6	2964	30.4	-2253	-23.1
	Average	9420	1017	10.8	2036	21.6	-1327	-14.0
Feed grain net exports (EC)	1986	1905	559	29.3	1649	86.6	-536	-28.1
	1987	3692	1253	33.9	2582	69.9	-1545	-41.8
	1988	4353	1826	41.9	3484	80.0	-2467	-56.7
	1989	4984	2386	47.9	4335	81.4	-3313	-66.5
	Average	3711	1528	41.0	3040	82.0	-1943	-52.0
Soymeal net imports (EC)	1986	10299	137	1.3	450	4.4	-115	-1.1
	1987	11578	301	2.6	677	5.8	-369	-3.2
	1988	12953	430	3.3	886	6.8	-590	-4.5
	1989	14104	550	3.9	1079	7.6	-784	-5.6
	Average	12233	355	2.9	773	6.3	-464	-3.8

[a]Simulation #1 is generated by keeping the policy price endogenous and continuing the same policy prevailed in 1968-1982.

[b]Simulation #2 is generated by keeping the real price constant.

[c]Simulation #3 is generated by a five percent annual decline in nominal price.

[d]Base is generated by keeping the policy price constant.

Table 5.1. continued

Variable	Year	Base (1000 MT)	Simulation #1		Simulation #2		Simulation #3	
			Change (1000 MT)	% change	Change (1000 MT)	% change	Change (1000 MT)	% change
Wheat net exports	1986	16948	576	3.4	2023	11.9	-435	-2.6
	1987	19364	1259	6.5	2995	15.5	-1535	-7.9
	1988	21284	1795	8.4	3897	18.3	-2497	-11.7
	1989	23052	2297	9.9	4731	20.5	-3335	-14.5
	Average	20162	1487	7.3	3411	17.0	-1951	-9.7
World price	1986	97.8	-1.4	-1.4	-4.1	-4.2	1.3	1.3
	1987	82.3	-3.0	-3.6	-6.1	-7.4	3.8	4.6
	1988	64.5	-4.6	-7.1	-8.6	-13.3	6.1	9.5
	1989	68.1	-6.0	-8.8	-10.9	-16.0	8.4	12.3
	Average	78.2	-3.8	-4.8	-7.5	-9.5	4.9	6.2
U.S. net exports	1986	41288	-475	-1.1	-1398	-3.4	453	1.1
	1987	61872	-853	-1.4	-1572	-2.5	1108	1.8
	1988	67138	-1106	-1.6	-2073	-3.1	1538	2.3
	1989	68430	-1364	-1.9	-2440	-3.6	1912	2.8
	Average	59682	-950	-1.6	-1871	3.1	1252	2.1
Canada net exports	1986	3253	-23	-0.7	-69	-2.1	23	0.7
	1987	10265	-199	-1.9	-540	-5.2	205	2.0
	1988	9312	-391	-4.2	-777	-8.3	497	5.3
	1989	7844	-541	-6.9	-1020	-13.0	739	9.4
	Average	7668	-288	-3.7	-601	-7.8	367	4.8
Australia net exports	1986	2864	-14	-0.5	-40	-1.4	14	0.5
	1987	3034	-39	-1.3	-91	-3.0	47	1.5
	1988	2851	-70	-2.5	-145	-5.1	91	3.2
	1989	2752	-105	-3.8	-202	-7.3	142	5.2
	Average	2875	-57	2.0	-12	4.1	74	2.6
Japan net imports	1986	22593	25	0.1	73	0.4	-23	-0.1
	1987	23571	59	0.2	127	0.5	-71	-0.3
	1988	24952	73	0.3	131	0.5	-103	-0.4
	1989	25636	86	0.3	156	0.6	-120	-0.5
	Average	24188	60	0.2	122	0.5	-80	-0.3
U.S.S.R. net imports	1986	20455	50	0.2	146	0.7	-46	-0.2
	1987	21824	104	0.5	208	0.9	-129	-0.6
	1988	22759	145	0.6	276	1.2	-197	-0.9
	1989	20598	180	0.9	327	1.6	-251	-1.2
	Average	21409	119	0.5	239	1.1	156	-0.7

Table 5.1. continued

Variable	Year	Base (1000 MT)	Simulation #1 Change (1000 MT)	Simulation #1 % change	Simulation #2 Change (1000 MT)	Simulation #2 % change	Simulation #3 Change (1000 MT)	Simulation #3 % change
Spain net imports	1986	6199	-57	-0.9	-168	-2.7	55	0.9
	1987	6742	-147	-2.2	-320	-4.7	176	2.6
	1988	7436	-228	-3.1	-441	-5.9	303	4.1
	1989	7939	-296	-3.7	-545	-6.9	409	5.1
	Average	7079	-182	-2.6	-369	5.2	236	3.3
Argentine net exports	1986	11751	-30	0.2	-89	-0.8	29	0.2
	1987	13821	-135	-0.9	-335	-2.4	148	1.0
	1988	13258	-246	-1.9	-483	-3.6	318	2.4
	1989	13147	-378	-2.9	-704	-5.3	517	3.9
	Average	12994	-197	1.5	-403	3.1	248	1.9
Thailand net exports	1986	2732	-2	-0.1	-5	-0.2	1	0.0
	1987	2943	-11	-0.4	-29	-1.0	11	0.4
	1988	2924	-21	-0.7	-41	-1.4	26	0.9
	1989	2907	-30	-1.0	-55	-1.9	39	1.3
	Average	2876	-16	-0.6	-32	-1.1	20	0.7

Table 5.2. Policy change, impact on the price and net trade of the EC and other regions

Variable	Year	Base (1000 MT)	Simulation #4[a] Change (1000 MT)	Simulation #4[a] % change	Simulation #5[b] Change (1000 MT)	Simulation #5[b] % change
Corn threshold price	1986	235	6	2.6	-31	-13.2
	1987	235	21	8.9	-56	-23.8
	1988	235	29	12.3	-81	-34.5
	1989	235	37	15.7	-78	-33.2
	Average	235	23	9.8	-62	-26.0
Corn net imports	1986	7084	832	11.7	1091	15.4
	1987	5515	966	17.5	1780	32.3
	1988	5077	1160	22.9	2443	48.1
	1989	4672	962	20.6	2283	48.9
	Average	5587	980	17.5	1899	34.0
Barley net exports	1986	9089	-2022	-22.3	-1878	-20.7
	1987	9307	-1898	-20.4	-3334	-35.8
	1988	9530	-1946	-20.4	-4798	-50.4
	1989	9756	-1475	-15.1	-4559	-46.7
	Average	9420	-1835	-19.0	-3642	-38.6
Feed grain net exports	1986	1905	-2854	-149.8	-2969	-155.9
	1987	3692	-2864	-77.6	-5114	-138.5
	1988	4353	-3105	-71.3	-7241	-166.4
	1989	4984	-2437	-48.9	-6842	-137.3
	Average	3711	-2793	-75.0	-5519	-148.0
Soymeal net imports	1986	10299	-2129	-20.7	-887	-8.6
	1987	11578	-2426	-21.0	-1385	-12.0
	1988	12953	-2530	-19.5	-1857	-14.3
	1989	14104	-2270	-16.1	-1735	-12.3
	Average	12233	-2338	-19.0	-1327	-12.0
Wheat net exports	1986	16948	-1283	-7.6	-3054	-18.0
	1987	19364	-444	-2.3	-5137	-26.5
	1988	21284	98	0.5	-7123	-33.5
	1989	23052	870	3.8	-6592	-28.6
	Average	20162	-190	-1.0	-5477	-27.0

[a]Simulation #4 is generated by the consumer paying border price and producers receiving the same price as before (prices in simulation #1).

[b]Simulation #5 is genererted by reducing the variable levy (for grains) by 50 percent and imposing the same levy on soymeal prices.

Table 5.2. continued

Variable	Year	Base (1000 MT)	Simulation #4 Change (1000 MT)	Simulation #4 % change	Simulation #5 Change (1000 MT)	Simulation #5 % change
World price	1986	97.8	8.1	8.3	7.1	7.3
	1987	82.3	7.6	9.2	12.0	14.6
	1988	64.5	9.0	14.0	17.8	27.6
	1989	68.1	7.0	10.3	16.3	24.0
	Average	78.2	7.9	10.0	13.3	17.0
U.S. net exports	1986	41288	2854	6.9	2504	6.1
	1987	61872	1631	2.6	3213	5.2
	1988	67138	2069	3.1	4369	6.5
	1989	68430	1256	1.8	3204	4.7
	Average	59682	1952	3.0	3322	5.6
Canada net exports	1986	3253	142	4.4	125	3.8
	1987	10265	1023	10.0	987	9.6
	1988	9312	945	10.2	1558	16.7
	1989	7844	1011	12.9	2033	25.9
	Average	7668	780	10.0	1177	15.3
Australia net exports	1986	2864	83	2.9	73	2.6
	1987	3034	147	4.9	177	5.8
	1988	2851	187	6.6	292	10.2
	1989	2752	197	7.2	363	13.2
	Average	2875	154	5.3	226	7.8
Japan net imports	1986	22593	-147	-0.7	-129	-0.6
	1987	23571	-180	-0.8	-248	-1.1
	1988	24952	-114	-0.5	-278	-1.1
	1989	25636	-100	-0.4	-239	-0.9
	Average	24188	-135	-0.6	-224	-0.9
U.S.S.R. net imports	1986	20455	-296	-1.5	-259	-1.3
	1987	21824	-259	-1.2	-413	-1.9
	1988	22759	-290	-1.3	-573	-2.5
	1989	20598	-210	-1.02	-490	-2.4
	Average	21409	-264	-1.2	-434	-2.0
Spain net imports	1986	6199	860	13.9	289	4.7
	1987	6742	1011	15.0	604	9.0
	1988	7436	1119	15.1	890	12.0
	1989	7939	1021	12.9	902	11.4
	Average	7079	1003	14.0	671	9.4

Table 5.2. continued

Variable	Year	Base (1000 MT)	Simulation #4 Change (1000 MT)	Simulation #4 % change	Simulation #5 Change (1000 MT)	Simulation #5 % change
Argentina net exports	1986	11751	182	1.6	159	1.4
	1987	13821	581	4.2	627	4.5
	1988	13258	569	4.3	978	7.4
	1989	13147	629	4.8	1306	9.9
	Average	12994	490	3.8	767	5.9
Thailand net exports	1986	2732	9	0.3	8	0.3
	1987	2943	53	1.8	53	1.8
	1988	2924	49	1.7	82	2.8
	1989	2907	52	1.8	106	3.7
	Average	2876	41	1.4	63	2.2

The impacts are then reported for the period 1986-1989, and for selected variables. These variables are: the net feed grain trade of each region and the world price (considered to be the U.S. corn price). Since all other feed grain prices follow the world price, as is built into the model, the developments in the world price are, then, a good approximation of the percentage changes in all other prices. Furthermore, the results for each scenario are presented in two tables: one for the EC and one for the developed and the developing countries.

Price Modification Scenarios

One of the unexpected features of the CAP prices is the apparent declining trend in the real threshold prices (Figure 5.1). It is also claimed by the EC authorities (EC Commission, 1983), that the price increments have not been keeping up with the inflation rate in the EC. In this regard, the appropriateness of the aggregation methods arriving at the common CPI, and the commonness of the prices in different member countries, could be questioned and discussed. Important as it may be, however, it is not the concern of this study to examine the CPI. Assuming that the CPI used in this study is the appropriate proxy for the general price level in the EC, then real prices are kept constant at their 1986 level to produce the first price modification scenario. The last of the price modification scenarios is produced by a five percent annual reduction in the nominal policy prices, starting in the 1986-87 crop year. The results are presented in Tables 5.1-5.6.

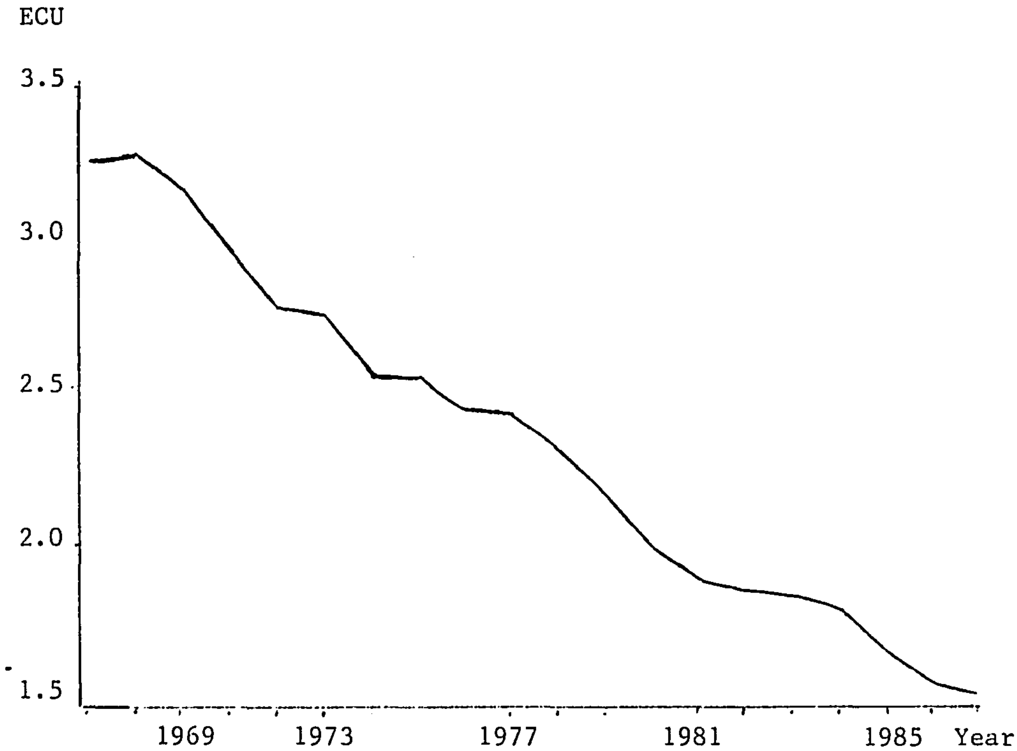


Figure 5.1. EC real threshold price of corn

The EC impacts

When the real prices are kept constant (simulation #2), the impact on production is more significant than the impact on consumption. Furthermore, the increment in nominal price encourages more substitution of soymeal for grain (a five percent rise in soymeal imports). The final result, then, is a 52 percent increase, on average, in the net feed grain export over the period of 1986-1989. In the case of the wheat market, in which the EC is already a significant net exporter in 1986, the constant real price scenario results in a 17 percent rise in the average 1986-1989 net exports.

As expected, an annual five percent reduction (starting in 1986) in nominal prices brings about a reduction in production. A 14 percent decline in barley exports and a 11.4 percent increase in corn imports results in a 52 percent reduction in feed grain net exports for the 1986-1989 period. The percentage reduction in exports differs for each year, and has an increasing trend over the forecast period. It rises from 28 percent for 1986 to almost 90 percent for 1989. The imports of soymeal, too, decline by four percent. The impact on the wheat sector is not as dramatic as the net export drops by ten percent.

The impact on the other regions

The developments in the EC market translate into different impacts on different regions. The results generated by the constant real price scenario suggest a reduction in the world price and, accordingly, a reduction in the exports of the exporting countries and an increase in the imports of the importing regions. Within the developed exporting regions, although the impact on the U.S. is minimal, on a percentage basis, in terms of the change in the level of exports, the U.S. loss is maximum as compared with other exporters. The reduction in Canadian exports is next to that of the U.S. Within the importing regions, the Soviet Union and Japan do not show a significant response to the change in prices. However, Spain, by joining the EC and following the same price policies, reduces its imports by approximately five percent.

The gradual liberalization (simulation #3, five percent annual reduction in nominal price) is suggested to result in a two percent increase in U.S. exports, following the six percent rise in the world price. Due to the gradual nature of this policy, the impacts accumulate over the years and are more significant in the later years (1988 and 1989). Even more important results could be expected in the following periods excluded from this study.

Producer Price Subsidy Scenario

One of the policies suggested by the critics of the trade barriers is the producer subsidy program. It is argued that if the major objective of the EC is to maintain the rural standard of living, then there is no need to restrict imports. Instead, the EC could subsidize production. It could easily be inferred, in this case, that the immediate outcome, in the absence of any import levy, would be a jump in budget deficit. However, it will be helpful to examine the impact on other countries.

This scenario allows the consumer prices to compete with the prices prevailing in the world market. At the same time, producers are subsidized to receive almost the same prices as in the base scenario. Therefore, the market is open and only the producers are protected from the world market.

Impact on the EC

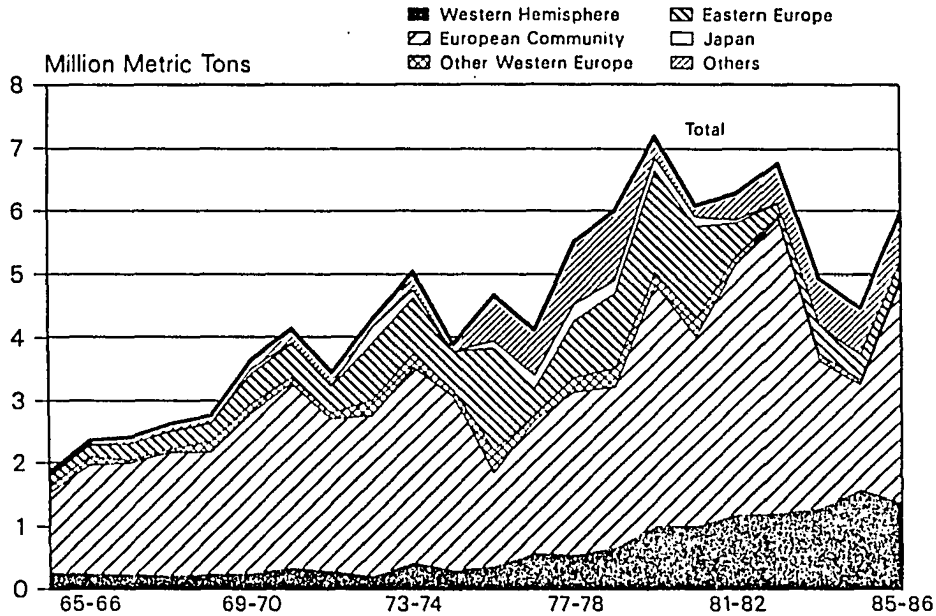
This policy generates a 46 percent reduction in consumer prices, followed by an increase in consumption. This, in turn, raises the corn imports by 17 percent and reduces barley and feed grain exports by 19 and 75 percent, respectively. This policy also produces a 20 percent decline in soymeal imports, but wheat exports do not fall significantly, due to low elasticity of demand. The net result for the community is a very significant jump in budget costs in the absence of a related source of revenue.

Impact on other countries

The rise in the EC corn imports, although it increases the exports of the corn exporting countries, but after accounting for the fall in soybean exports, will not leave these countries with a significant net gain. This policy raises the world price level by eight percent on average. It also will raise U.S. exports by two million MT, which accounts for three percent of total U.S. feed grain exports for the 1986-1989 average. In the case of other exporting regions, the increases in the exports of Canada, Argentina, Australia, and Thailand fall orderly behind the U.S. The impact on the importing regions is negative, as expected (due to the increase in the world price), but again it is not very important. The net imports of Spain drop by 14 percent.

Oilseed-Grain Protection Harmonization Scenario

GATT provisions prevent the EC from imposing trade barriers on soymeal imports. Moreover, the U.S. has strongly aired the opposition to any policy, since the U.S. is a major exporter of this commodity and the EC is a major market for it (Figure 5.2). On the other hand, EC producers and authorities correctly argue that in the absence of some sort of restriction on oilseed imports, oilseed has replaced grain in feed use and is responsible for a major part of the grain surplus that has been so much under criticism. Therefore, under the present GATT provisions, such a policy will not be followed, but since a new round of GATT negotiations is on the near horizon, it will be beneficial to examine a policy of compromise, i.e., reducing the protection rate on grain and instead raising the protection level of soymeal. As studied by Huyzer (1983), a levy on soybeans will not be effective in reducing soymeal use since soymeal imports, in that case, will replace soybean imports in the EC. However, a similar levy on soymeal places an effective pressure on the soymeal demand. Peterson and Auerbach (1985) conclude that import duties on soybeans and soymeal "... would do little to reduce the excess production [of grain] ... the benefits to the EC ... may be considerably smaller than anticipated." But, they are quick to mention that they have only studied the French market for which an



Note: 1985-86 exports are projected using the October 1985-March 1986 percentage change from a year earlier.
Source: U.S. Department of Agriculture, Agricultural Marketing Service, *Grain and Feed Market News* (Independence, Mo.), various issues, and *Grain Market News* (Independence, Mo.), various issues, and *Foreign Agricultural Circular*, Oilseeds and Products (Washington, D.C.), FOP 5-86, May 1986.

Figure 5.2. US soymeal exports by destination (World Food Institute 1986)

extensive soybean crushing industry is not present, and at the same time is well over sufficient in corn production followed by lower grain prices, as compared to other EC members.

In this study, the levy on grain is reduced by 50 percent, and simultaneously the same levy is imposed on soymeal (simulation #5). The anticipated impact, then, is an increase in grain consumption, a decline in exports of grain and in imports of soymeal, in the EC. We turn now to the empirical results to examine the outcome generated by the model.

Impact on the EC

This policy is by far the most effective of all scenarios examined by this study in reducing the surplus production (a 148 percent reduction in the net feed grain exports). These results are in agreement with the a priori expectations, since the grain policy prices are reduced by 26 percent for the average 1986-1989 period. Following this policy, the EC turns into a net importer of feed grain (by 1987), due to a 34 percent rise in corn imports and a 38 percent decline in barley exports. However, the net imports of soymeal decline by as much as 12 percent. The surplus in the wheat sector, too, is reduced by 27 percent.

Impact on other countries

The grain-soymeal protection harmonization scenario creates the largest impact in the world market as well (compared to other scenarios). It results in a 17 percent rise in world prices of grain, and it adds 3.3 million metric tons to U.S. feed grain exports (an increase of 5.6

percent) on average for the 1986-1989 period. The net exports of Canada and Australia, on average, will rise by 15.3 and 7.8 percent, respectively, which translates to 1177 and 226 million metric tons. Argentina and Thailand observe a 5.9 percent and a 2.2 percent increase in their exports. The importing regions will bring down their imports, as expected, but only by 0.9 and two percent for Japan and the Soviet Union, respectively. The decline in the imports of Spain is the largest (9.4 percent).

CHAPTER VI. SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

The ultimate concern of this study was to analyze the impacts of possible reforms in the common agricultural policy of the EC on the world trade. But, first, it is necessary to build an understanding of the behavioral relationships in the world feed grain market, and of the EC policy making process. To meet this first objective, extensive literature and data on the working of the domestic market for each of the major participants in the world feed grain market have been reviewed. The result is a qualitative description of each market, presented in the second chapter. To approach the major concern, however, the existing literature, dealing with problems related to the one stated above, needs to be reviewed to attain a better and a more clear understanding of the problem, and to build upon the available knowledge on the particular subject of interest. This is achieved in the first chapter. Review of the literature drives one to conclude that the major beneficiary (of a less protective policy for the EC grain sector) in the world market is the U.S., as compared with other regions, on the basis of the change in the level of exports. But, considering the agricultural market in a more general sense, the net gain for the U.S. is not as high as it may be in a partial market study.

The third chapter examines the conceptual framework of the model. It is illustrated: that the demand for feed grain is derived from the demand for meat, itself responding to the changes in income; that the variations in yield particularly in the more technologically advanced and commercialized regions, is not only a function of noneconomic variables, but also of economic variables triggered by government policies, and the input prices. The decision for the number of hectares to plant this period is made by speculating the prices. This expectation is assumed in this study to be based only on the prices prevailing in the last period. It is also shown that the price policies in the EC are determined by a set of factors including the budget pressure, self-sufficiency, and standard of living. World prices of grain enter this relation, but only indirectly. In order to do the analysis, the use of a multi-region nonspatial price equilibrium trade model is justified. The nonlinear two-stage least square procedure is then chosen to carry out the statistical analysis.

The next chapter exploits the observations for the 1968-1982 period to arrive at the quantitative estimates of the parameters of the behavioral relations, and to test those relationships. The majority of the parameters estimated in the model are proven to be statistically significant, and economically reasonable. The historical simulation of the model, then, is examined to evaluate the performance of the model. The model appears to be in generally good shape, and has a reasonable performance, as judged by different measures such as: statistics of fit, Theil's forecast error measures, and the number of turning points accurately simulated by the model.

Finally, several policy alternatives for the EC common agricultural policy are examined in terms of their impact on grain prices and regional trade. First, a trio of policies, categorized as price modification scenarios, are studied. These policies are: to keep real threshold prices constant, to keep nominal threshold price constant, and to reduce the threshold price by five percent annually. The constant nominal price scenario is chosen as the basis for comparison. Since the real threshold price has a decreasing trend, then keeping it constant could be achieved by increasing the nominal price level. Therefore, constant real price policy increases the net export in the EC, followed by a reduction in the world price of grain, and the grain exports of other exporting countries. On the other hand, liberalizing the market at a relatively modest steady rate does not create a drastic result in the early years, but by the third year (of its adoption) it starts to create a significant reduction in the EC feed grain exports, and consequently raises world price and the exports of other exporting countries.

In the next scenario, a policy is adopted to subsidize producers, but at the same time consumer prices are allowed to compete with the prices prevailing in the world market. This policy brings down the consumer price of feed grain in the EC by 46 percent. This in turn raises the consumption of feed grains, partly replacing the soymeal in feed use. Feed grain exports, as a result, decline, which paves the way for a rise (eight percent) in the world grain prices and the exports of the exporting countries. More impressive, for other exporting countries, is the policy of harmonizing protection in the EC grain sector and in its soymeal sector. Adopting this policy will turn the EC into a net importer of feed grains, since prices for both consumers and producers in the EC are brought down. This will further raise the world price by ten percent, followed by a rise in the exports of other exporting countries.

In conclusion, one can say that at the same time that the EC common agricultural policies do have impact in the world market developments, but, for example, in the case of the U.S., even under the most extreme of the policies analyzed in this study, this impact does not go beyond five percent. And, it was only for one of the exporting regions that the impact on the net quantity traded moves close to 20 percent. However, in terms of the changes in the level of grain exports, the major beneficiary of any reduction in the EC prices are the U.S. grain producers. These results are in line with those of previous studies (such as, Koester, 1982, and Meyers et al., 1985, etc.). For the importing countries, except for Spain, the changes are not considered to be very significant. Furthermore, the policies that have a more compromising nature do produce the more reasonable and steady results, i.e., gradual liberalization and grain-soymeal protection trade-off.

While this study is not equipped to predict the impact of the complete liberalization of the EC grain sector, it is not hard to realize the unrealistic nature of such action (mainly due to domestic political opposition). Therefore, the implications, as relevant for the upcoming GATT negotiations, could be that other exporting countries should propose the more compromising policy alternatives, to be able to proceed with a more fruitful negotiation.

Several suggestions could be made for further research:

- The EC model could be expanded by accounting for the policy price differentials in different member countries, and by allowing for the differences between prices paid by consumers, prices received by farmers, and policy prices pursued by the EC authorities. Further differentiation between the different grades of barley and wheat exported and imported could enhance the accuracy and performance of the model.

- The improvement in the EC model could further be achieved by endogenizing the livestock sector, and a more thorough study of the oilseed industry and other feed components.
- Other important regions left out of this study, as described in the last three regions in Chapter II, could be endogenized in the model in order to enhance the accuracy of the forecasts.

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APPENDIX

This appendix is devoted to identifying the countries represented in each region, and the supply utilization tables for each region.

Regional identification

Region	Code[a]	Countries
EC-10	EO	Belgium/Luxemburg, West Germany, Denmark, France, United Kingdom, Ireland, Italy, Netherlands, Greece
United States	U9	
Argentina	AR	
Canada	CA	
Australia	AU	
Thailand	TH	
Japan	JP	
U.S.S.R.	SU	
Spain	ES	
High income East Asia	R4	Singapore, Brunei, South Korea, Hong Kong, Taiwan
Eastern Europe	E8	Albania, Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, Yugoslavia
Residual world	RW	all other countries

[a]This code is related to the last two letters at the end of each variable name.

Table A.1. EC supply/utilization corn (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	2,230	3.11076	6,937	8,059	697	12,070	2,556	14,626	1,552
1961	2,373	2.80657	6,660	10,428	450	13,414	2,662	16,076	2,114
1962	2,166	2.48753	5,388	11,394	535	13,906	2,724	16,630	1,731
1963	2,272	3.46215	7,866	13,054	1,285	16,240	3,169	19,409	1,957
1964	2,134	2.98454	6,369	12,936	1,467	15,444	3,007	18,451	1,344
1965	2,069	3.42388	7,084	15,422	1,958	16,838	3,276	20,114	1,778
1966	2,123	3.88789	8,254	15,294	2,178	17,247	3,551	20,798	2,350
1967	2,206	3.86854	8,534	15,677	1,666	18,988	3,774	22,762	2,133
1968	2,196	4.55556	10,004	14,333	2,950	17,859	3,960	21,819	1,701
1969	2,414	4.58161	11,060	14,492	3,212	17,761	4,104	21,865	2,176
1970	2,779	4.79957	13,338	15,048	4,867	18,834	4,761	23,595	2,100
1971	2,911	4.98385	14,508	16,312	4,729	19,909	6,169	26,078	2,113
1972	3,061	4.62235	14,149	17,456	4,515	20,704	5,800	26,504	2,699
1973	3,122	5.45356	17,026	19,519	6,985	22,532	6,277	28,809	3,450
1974	3,051	4.86398	14,840	18,747	5,487	21,634	6,163	27,797	3,753
1975	3,096	4.72836	14,639	18,134	5,392	22,507	5,985	28,492	2,642
1976	2,526	4.69794	11,867	22,837	4,772	23,415	6,547	29,962	2,612
1977	2,847	5.67861	16,167	17,585	4,399	22,938	6,337	29,275	2,690
1978	2,974	5.67787	16,886	18,333	4,793	22,821	7,267	30,088	3,028
1979	3,177	5.70822	18,135	16,861	5,455	22,780	7,247	30,027	2,542
1980	2,982	5.88196	17,540	15,020	4,641	20,367	7,003	27,370	3,091
1981	2,866	6.40649	18,361	13,583	4,927	20,219	7,019	27,238	2,870
1982	2,988	6.62784	19,804	11,542	6,181	17,851	7,146	24,997	3,038

Table A.2. EC supply/utilization barley (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	5,901	2.99136	17,652	3,310	1,448	14,098	4,901	18,999	2,308
1961	6,511	2.73767	17,825	4,245	2,535	15,046	5,178	20,224	1,619
1962	6,553	3.20220	20,984	3,002	1,696	16,279	5,313	21,592	2,317
1963	7,323	3.14325	23,018	3,058	2,765	17,510	5,418	22,928	2,700
1964	7,271	3.31220	24,083	3,105	2,927	18,685	6,096	24,781	2,180
1965	7,679	3.28428	25,220	4,183	3,205	19,206	6,448	25,654	2,724
1966	8,465	3.13833	26,566	3,553	3,555	20,694	6,412	27,106	2,182
1967	8,724	3.56110	31,067	3,640	3,991	23,691	6,739	30,430	2,468
1968	8,731	3.42721	29,923	3,747	4,224	22,569	6,230	28,799	3,115
1969	8,889	3.49038	31,026	4,394	4,790	24,648	6,852	31,500	2,245
1970	9,052	3.08882	27,960	6,146	2,942	24,121	6,977	31,098	2,311
1971	8,892	3.58547	31,882	5,074	5,439	24,222	7,363	31,585	2,243
1972	9,012	3.83000	34,516	4,471	5,277	25,435	8,436	33,871	2,082
1973	9,315	3.79614	35,361	5,611	5,674	26,611	8,802	35,413	1,967
1974	9,157	3.91329	35,834	4,503	4,778	25,442	9,437	34,879	2,647
1975	9,428	3.53787	33,355	5,203	5,557	24,966	9,189	34,155	1,493
1976	9,324	3.32218	30,976	6,554	3,691	25,128	8,751	33,879	1,453
1977	9,849	3.89776	38,389	5,838	7,970	26,694	9,391	36,085	1,625
1978	9,894	4.08793	40,446	4,558	7,187	27,716	9,338	37,054	2,388
1979	10,007	3.98451	39,873	4,600	6,837	27,894	9,471	37,365	2,659
1980	9,778	4.23287	41,389	4,716	8,692	28,543	9,165	37,708	2,364
1981	9,796	4.01511	39,332	5,299	8,781	26,929	9,237	36,166	2,048
1982	9,305	4.43966	41,311	4,509	8,251	27,039	9,298	36,337	3,280

Table A.3. EC supply/utilization wheat (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	12,886	2.30452	29,696	11,706	2,599	7,667	29,919	37,586	7,662
1961	12,249	2.30402	28,222	11,840	3,280	7,119	29,874	36,993	7,451
1962	13,194	2.75959	36,410	8,378	4,291	8,052	30,368	38,420	9,528
1963	12,060	2.47438	29,841	9,729	4,396	7,456	29,905	37,361	7,341
1964	13,003	2.76921	36,008	8,798	6,174	8,504	30,391	38,895	7,078
1965	13,110	2.86232	37,525	10,150	6,522	8,861	30,870	39,731	8,500
1966	12,213	2.66274	32,520	9,335	5,371	8,291	29,953	38,244	6,740
1967	11,877	3.19281	37,921	9,138	6,278	8,692	29,825	38,517	9,004
1968	12,472	3.07328	38,330	11,841	8,368	9,913	32,120	42,033	8,774
1969	12,207	3.06595	37,426	11,397	9,816	12,257	30,313	42,570	5,211
1970	11,911	3.07925	36,677	12,180	5,724	12,515	30,135	42,650	5,694
1971	12,114	3.47367	42,080	11,238	8,875	12,129	30,829	42,958	7,179
1972	11,952	3.61630	43,222	12,047	11,883	14,620	30,069	44,689	5,876
1973	11,692	3.68893	43,131	12,134	11,660	11,793	30,152	41,945	7,536
1974	12,159	3.92014	47,665	9,905	12,259	12,244	30,573	42,817	10,030
1975	11,381	3.53071	40,183	11,953	14,507	9,441	30,536	39,977	7,682
1976	12,120	3.42120	41,465	9,651	10,899	9,949	30,546	40,495	7,404
1977	10,977	3.66266	40,205	12,512	12,640	10,733	30,533	41,266	6,215
1978	11,956	4.20383	50,261	10,643	15,304	11,936	30,754	42,690	9,125
1979	11,975	4.07866	48,842	10,859	17,504	12,271	31,048	43,319	8,003
1980	12,567	4.38243	55,074	10,315	20,697	12,807	31,065	43,872	8,823
1981	12,645	4.30059	54,381	11,162	22,087	13,718	30,841	44,559	7,720
1982	13,001	4.59949	59,798	9,349	21,108	15,107	29,397	44,504	11,255

Table A.4. EC supply/utilization feed grains (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	15,352	2.75730	42,330	14,562	2,613	43,060	11,201	54,261	6,380
1961	15,812	2.53055	40,013	18,423	3,273	44,474	11,458	55,932	5,611
1962	15,346	2.80659	43,070	18,474	2,688	46,344	11,617	57,961	6,506
1963	15,972	2.96682	47,386	19,378	4,380	48,968	12,926	61,894	6,996
1964	15,394	3.03579	46,733	19,445	4,761	50,091	12,317	62,408	6,005
1965	15,459	3.03629	46,938	23,599	5,612	51,345	12,916	64,261	6,669
1966	16,139	3.05930	49,374	22,543	6,215	52,740	13,034	65,774	6,967
1967	16,409	3.40965	55,949	21,952	6,251	58,092	13,770	71,862	6,355
1968	16,151	3.45192	55,752	19,992	7,705	54,472	13,011	67,483	6,911
1969	16,305	3.52137	57,416	20,512	8,545	56,087	13,719	69,806	6,488
1970	16,587	3.29758	54,697	24,250	8,524	56,339	14,478	70,817	6,094
1971	16,488	3.75079	61,843	22,954	10,843	57,619	16,527	74,146	5,902
1972	16,500	3.84339	63,416	23,615	10,928	58,593	17,249	75,842	6,163
1973	16,514	3.99855	66,032	27,861	13,780	61,739	17,905	79,644	6,632
1974	16,162	3.98738	64,444	25,737	11,130	59,528	18,273	77,801	7,882
1975	16,449	3.69633	60,801	26,657	12,413	60,081	17,703	77,784	5,143
1976	15,655	3.39879	53,208	32,572	9,503	58,462	17,795	76,257	5,163
1977	16,367	4.06061	66,460	24,978	13,311	59,397	18,221	77,618	5,672
1978	16,337	4.28953	70,078	24,316	13,152	60,668	19,109	79,777	7,137
1979	16,286	4.24457	69,127	22,611	13,316	60,100	18,983	79,083	6,476
1980	15,759	4.42268	69,697	20,810	14,251	57,561	18,448	76,009	6,723
1981	15,490	4.37579	67,781	19,834	14,382	55,399	18,514	73,913	6,043
1982	15,101	4.74181	71,606	16,785	15,010	53,457	18,594	72,051	7,373

Table A.5. United States supply/utilization feed grains (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	52,267	2.71512	141,911	366	11,192	109,236	12,362	121,598	77,423
1961	43,241	2.94836	127,490	398	15,250	111,566	12,821	124,387	65,674
1962	42,036	3.08319	129,605	145	15,242	108,678	12,889	121,567	58,615
1963	43,174	3.24897	140,271	287	16,653	106,101	13,365	119,466	63,054
1964	40,000	3.06365	122,546	375	19,629	101,572	13,302	114,874	51,472
1965	39,490	3.65173	144,207	304	25,718	115,993	14,054	130,047	40,218
1966	40,152	3.60931	144,921	271	20,101	115,526	14,259	129,785	35,524
1967	41,311	3.94379	162,922	283	20,682	117,860	14,588	132,448	45,599
1968	39,782	3.90280	155,261	308	16,301	122,705	14,974	137,679	47,188
1969	39,187	4.12591	161,682	352	18,955	128,883	15,287	144,170	46,097
1970	40,735	3.58674	146,106	363	18,612	126,851	14,938	141,789	32,165
1971	43,637	4.34340	189,533	343	24,165	136,002	15,282	151,284	46,592
1972	38,377	4.74276	182,013	442	38,747	142,302	16,265	158,567	31,733
1973	41,628	4.48681	186,777	221	40,669	139,485	16,733	156,218	21,844
1974	40,685	3.70911	150,905	494	35,925	105,409	16,429	121,838	15,480
1975	42,625	4.35059	185,444	437	50,031	115,633	18,367	134,000	17,330
1976	43,268	4.49189	194,355	349	50,604	113,276	18,104	131,380	30,050
1977	44,223	4.65213	205,731	304	56,290	119,220	19,093	138,313	41,482
1978	43,157	5.14725	222,140	262	60,199	137,346	19,896	157,242	46,443
1979	41,834	5.70701	238,747	302	71,369	138,840	22,560	161,400	52,723
1980	41,341	4.79981	198,429	255	69,506	123,224	23,988	147,212	34,689
1981	43,583	5.71250	248,958	250	58,565	130,770	26,050	156,820	68,522
1982	43,598	5.84020	254,621	378	54,020	142,874	28,361	171,235	98,266

Table A.6. Argentina suuply/utilization feed grains (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	5,718	1.48374	8,484	3	2,501	4,970	970	5,940	568
1961	5,595	1.57980	8,839	5	4,131	4,203	875	5,078	203
1962	4,424	1.46067	6,462	4	3,378	1,950	868	2,818	473
1963	5,905	1.56986	9,270	5	5,327	2,984	1,006	3,990	431
1964	5,661	1.48260	8,393	6	3,742	3,742	1,069	4,811	277
1965	5,417	1.93557	10,485	4	5,309	4,222	1,051	5,273	184
1966	5,645	1.92241	10,852	2	4,969	4,430	1,288	5,718	351
1967	6,248	1.65109	10,316	4	4,542	4,300	1,410	5,710	419
1968	6,641	1.64825	10,946	1	5,598	4,006	1,451	5,457	311
1969	7,333	2.00150	14,677	1	7,957	5,227	1,596	6,823	209
1970	7,468	2.09976	15,681	2	9,098	4,615	1,321	5,936	858
1971	5,951	1.61469	9,609	2	3,347	5,629	1,188	6,817	305
1972	7,641	2.08912	15,963	0	7,552	6,082	1,920	8,002	714
1973	7,521	2.38466	17,935	0	9,189	6,660	2,432	9,092	368
1974	6,228	2.21468	13,793	0	5,981	4,802	2,279	7,081	1,099
1975	5,908	2.10528	12,438	0	6,922	4,810	976	5,786	829
1976	6,363	2.64969	16,860	0	9,798	6,517	886	7,403	488
1977	6,138	2.98517	18,323	0	11,152	5,995	891	6,886	773
1978	6,369	2.70843	17,250	0	10,021	6,740	869	7,609	393
1979	4,832	2.19599	10,611	0	5,133	4,871	835	5,706	165
1980	6,414	3.28079	21,043	0	14,354	5,650	845	6,495	359
1981	6,387	2.87678	18,374	0	11,493	5,744	849	6,593	647
1982	6,340	2.85473	18,099	0	11,481	6,000	855	6,855	410

Table A.7. Canada supply/utilization feed grains (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	7,633	1.63553	12,484	504	1,016	10,335	1,694	12,029	4,523
1961	6,084	1.27202	7,739	778	992	7,706	1,555	9,261	2,787
1962	7,473	1.85428	13,857	735	818	10,371	1,720	12,091	4,470
1963	7,379	1.95216	14,405	554	1,324	10,828	1,656	12,484	5,621
1964	6,622	1.83147	12,128	422	1,066	11,096	1,695	12,791	4,314
1965	7,150	2.03287	14,535	565	1,188	12,003	1,720	13,723	4,503
1966	7,562	2.13184	16,121	531	1,340	12,934	1,960	14,894	4,921
1967	7,584	1.83492	13,916	747	1,024	12,300	1,923	14,223	4,337
1968	7,899	2.11343	16,694	803	597	12,490	2,046	14,536	6,701
1969	8,191	2.15090	17,618	644	1,691	13,884	2,248	16,132	7,140
1970	8,418	2.31338	19,474	267	4,276	14,849	2,297	17,146	5,459
1971	10,212	2.38876	24,394	234	5,342	15,731	2,800	18,531	6,214
1972	9,162	2.28291	20,916	868	3,740	15,773	2,595	18,368	5,890
1973	9,174	2.23632	20,516	1,386	2,716	16,343	2,393	18,736	6,340
1974	8,945	1.95942	17,527	1,062	2,983	13,879	2,219	16,098	5,848
1975	8,580	2.33112	20,001	697	4,968	14,161	2,323	16,484	5,094
1976	8,364	2.52427	21,113	660	4,439	14,343	2,104	16,447	5,981
1977	8,483	2.63645	22,365	386	4,032	15,561	1,576	17,137	7,563
1978	7,794	2.60264	20,285	700	3,913	15,106	1,591	16,697	7,938
1979	7,083	2.66991	18,911	1,029	4,674	16,071	2,444	18,515	4,689
1980	7,996	2.76851	22,137	1,436	4,784	15,459	2,561	18,020	5,458
1981	9,165	2.83372	25,971	836	7,454	15,585	2,692	18,277	6.534
1982	8,907	2.99394	26,667	759	6,578	16,076	2,629	18,705	8,677

Table A.8. Australia supply/utilization feed grains (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	2,851	1.15153	3,283	0	1,347	1,183	753	1,936	35
1961	2,509	0.96851	2,430	0	776	1,016	633	1,649	40
1962	2,452	1.08564	2,662	0	616	1,308	738	2,046	40
1963	2,473	1.06915	2,644	0	608	1,254	787	2,041	35
1964	2,527	1.10685	2,797	2	658	1,311	830	2,141	35
1965	2,761	0.87070	2,404	1	729	1,021	670	1,691	20
1966	3,080	1.26526	3,897	7	702	1,716	966	2,682	540
1967	2,749	0.74682	2,053	17	460	1,073	710	1,783	367
1968	3,249	1.18221	3,841	34	938	1,202	830	2,032	1,272
1969	3,417	1.09014	3,725	12	1,208	1,456	961	2,417	1,384
1970	4,281	1.29035	5,524	1	2,916	1,588	788	2,376	1,617
1971	4,562	1.27795	5,830	1	2,780	2,680	928	3,608	1,060
1972	3,946	0.92625	3,655	3	1,372	2,384	452	2,836	510
1973	3,742	1.26350	4,728	2	2,485	1,683	442	2,125	630
1974	3,323	1.34005	4,453	3	2,867	1,261	446	1,707	512
1975	3,909	1.43489	5,609	6	3,675	1,247	508	1,755	697
1976	3,951	1.27841	5,051	6	2,741	1,701	522	2,223	790
1977	4,395	0.96974	4,262	22	1,584	1,997	727	2,724	766
1978	4,745	1.50158	7,125	9	3,244	2,250	916	3,166	1,490
1979	4,223	1.47052	6,210	3	3,889	1,995	928	2,923	891
1980	4,307	1.21268	5,223	10	2,374	2,103	954	3,057	693
1981	4,833	1.37161	6,629	15	2,953	3,080	878	3,958	426
1982	4,482	0.83735	3,753	32	900	2,065	688	2,753	558

Table A.9. Thailand supply/utilization feed grains (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	285	1.90877	544	.	519	2	8	10	390
1961	298	2.00671	598	.	589	4	11	15	384
1962	321	2.07165	665	.	722	4	11	15	312
1963	392	2.20918	866	.	923	10	15	25	230
1964	550	1.73636	955	.	909	10	16	26	250
1965	591	1.85110	1,094	.	1,186	11	20	31	127
1966	646	1.91331	1,236	.	1,283	18	21	39	41
1967	641	2.16069	1,385	.	1,308	27	31	58	60
1968	641	2.45242	1,572	.	1,343	51	60	111	178
1969	718	2.47214	1,775	.	1,559	92	104	196	198
1970	867	2.35063	2,038	.	1,743	113	117	230	263
1971	1,066	2.28424	2,435	.	2,242	137	139	276	180
1972	1,113	1.28931	1,435	.	1,136	150	157	307	172
1973	1,162	2.16867	2,520	.	2,319	172	184	356	17
1974	1,426	1.94951	2,780	.	2,186	285	255	540	71
1975	1,514	2.08917	3,163	.	2,556	381	69	450	228
1976	1,514	1.93197	2,925	.	2,281	534	210	744	128
1977	1,395	1.34552	1,877	.	1,321	438	134	572	112
1978	1,606	1.88107	3,021	.	2,252	590	198	788	93
1979	1,654	2.15236	3,560	.	2,339	849	305	1,154	160
1980	1,684	2.10808	3,550	.	2,397	1,129	69	1,198	115
1981	1,950	2.40000	4,680	.	3,495	1,102	42	1,144	156
1982	2,070	1.82126	3,770	.	2,358	1,209	47	1,256	312

Table A.10. South Africa (Republic) supply utilization (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	5,176	1.11128	5,752	6	1,740	1,030	2,550	3,580	1,113
1961	5,389	1.17591	6,337	8	2,604	1,101	2,661	3,762	1,092
1962	5,574	1.16864	6,514	7	2,822	1,143	2,748	3,891	900
1963	5,632	0.83026	4,676	26	1,209	1,297	2,491	3,788	605
1964	5,386	0.95878	5,164	176	678	1,569	3,343	4,912	355
1965	5,343	1.04080	5,561	144	548	1,688	3,081	4,769	743
1966	5,842	1.81701	10,615	12	3,021	1,578	3,479	5,057	3,292
1967	5,702	1.00579	5,735	14	2,965	1,859	3,314	5,173	903
1968	5,261	1.08192	5,692	511	862	2,071	3,258	5,329	915
1969	5,228	1.26626	6,620	25	1,251	2,355	3,144	5,499	810
1970	5,452	1.70616	9,302	29	2,877	2,007	3,538	5,545	1,719
1971	5,559	1.82101	10,123	16	3,741	2,308	3,727	6,035	2,082
1972	4,450	1.01730	4,527	15	157	2,357	3,594	5,951	516
1973	5,474	2.17684	11,916	38	3,436	2,770	4,006	6,776	2,258
1974	5,478	1.76305	9,658	5	3,408	2,905	3,900	6,805	1,708
1975	5,513	1.40214	7,730	0	1,530	3,150	3,648	6,798	1,110
1976	5,471	1.87534	10,260	0	2,611	2,706	4,248	6,954	1,805
1977	5,282	2.07819	10,977	1	3,340	3,192	3,956	7,148	2,295
1978	5,034	1.75447	8,832	21	2,511	3,162	3,979	7,141	1,496
1979	5,130	2.28519	11,723	0	3,716	3,487	3,823	7,310	2,193
1980	4,991	3.06932	15,319	26	4,956	3,802	4,010	7,812	4,770
1981	5,341	1.65138	8,820	130	4,035	3,211	5,039	8,250	1,435
1982	4,812	0.92934	4,472	2,612	285	3,938	4,016	7,954	280

Table A.11. Japan supply/utilization feed grains (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	1,013	2.62290	2,657	1,878	0	2,651	1,862	4,513	514
1961	862	2.70650	2,333	2,437	0	3,309	1,397	4,706	578
1962	778	2.61954	2,038	2,949	0	3,805	1,227	5,032	533
1963	711	1.49789	1,065	4,568	0	4,469	1,162	5,631	535
1964	611	2.37480	1,451	5,100	0	4,867	1,648	6,515	571
1965	536	2.76306	1,481	5,192	0	4,869	1,734	6,603	641
1966	477	2.72117	1,298	7,163	0	6,806	1,751	8,557	545
1967	433	2.80831	1,216	7,747	2	6,892	1,912	8,804	702
1968	386	3.06995	1,185	8,517	7	7,627	1,977	9,604	793
1969	340	2.74412	933	10,050	4	8,817	1,951	10,768	1,004
1970	270	2.51111	678	10,476	0	9,261	1,855	11,116	1,042
1971	211	2.87204	606	10,274	0	9,112	2,194	11,306	616
1972	162	2.58025	418	12,048	0	10,161	1,759	11,920	1,162
1973	112	2.55357	286	14,111	0	11,922	1,858	13,780	1,779
1974	105	2.80000	294	13,116	0	11,535	1,783	13,318	1,871
1975	97	2.72165	264	13,535	0	11,906	2,231	14,137	1,533
1976	96	2.57292	247	15,894	0	13,186	2,522	15,708	1,966
1977	89	2.60674	232	16,954	0	14,424	2,443	16,867	2,285
1978	109	3.22018	351	17,871	0	15,639	2,474	18,113	2,394
1979	124	3.42742	425	18,888	0	16,354	2,829	19,183	2,524
1980	125	3.12000	390	18,863	0	16,145	3,086	19,231	2,546
1981	128	3.10938	398	18,319	0	15,944	3,340	19,284	1,979
1982	128	3.16406	405	18,697	0	15,653	3,382	19,035	2,046

Table A.12. USSR supply/utilization feed grains (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	50,087	1.14660	57,430	153	1,961	30,569	25,053	55,622	5,000
1961	52,653	1.11967	58,954	24	3,072	30,478	25,428	55,906	5,000
1962	51,442	1.17649	60,521	5	2,537	30,681	26,308	56,989	6,000
1963	52,174	0.93198	48,625	127	2,037	24,894	22,821	47,715	5,000
1964	52,878	1.23055	65,069	2	1,555	30,621	25,895	56,516	12,000
1965	48,825	1.08455	52,953	23	2,249	30,702	24,025	54,727	8,000
1966	46,622	1.32429	61,741	186	845	38,769	23,313	62,082	7,000
1967	47,518	1.29656	61,610	361	994	38,972	23,005	61,977	6,000
1968	47,020	1.40687	66,151	530	1,100	40,172	24,409	64,581	7,000
1969	48,564	1.48073	71,910	134	1,112	44,303	27,629	71,932	6,000
1970	46,611	1.64929	76,875	271	1,080	48,610	27,456	76,066	6,000
1971	46,434	1.56454	72,648	4,298	896	51,430	24,620	76,050	6,000
1972	53,523	1.35445	72,494	6,950	374	52,603	26,467	79,070	6,000
1973	55,167	1.82992	100,951	6,481	882	69,617	35,933	105,550	7,000
1974	59,381	1.67973	99,744	2,730	1,000	67,647	32,827	100,474	8,000
1975	58,091	1.13305	65,820	15,550	0	56,451	27,919	84,370	5,000
1976	60,866	1.88905	114,979	5,700	2,000	78,114	37,565	115,679	8,000
1977	60,647	1.52629	92,565	11,713	1,000	72,998	35,280	108,278	3,000
1978	57,965	1.81720	105,334	9,921	1,020	77,647	35,588	113,235	4,000
1979	61,171	1.32661	81,150	18,400	0	70,414	29,136	99,550	4,000
1980	57,873	1.39143	80,526	18,000	0	63,638	35,888	99,526	3,000
1981	58,039	1.24055	72,000	25,500	0	68,400	30,100	98,500	2,000
1982	58,006	1.48261	86,000	11,300	0	68,700	29,600	98,300	1,000

Table A.13. High Income East Asia supply/utilization feed grains (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	828	1.48551	1,230	235	8	130	1,370	1,500	51
1961	840	1.60000	1,344	453	21	154	1,501	1,655	172
1962	866	1.47113	1,274	536	54	152	1,483	1,635	293
1963	915	0.99672	912	442	55	139	1,322	1,461	131
1964	965	1.47150	1,420	291	21	172	1,230	1,402	419
1965	1,029	1.59086	1,637	189	10	214	1,496	1,710	525
1966	946	1.91226	1,809	228	23	279	1,618	1,897	642
1967	958	1.95511	1,873	654	5	567	1,754	2,321	843
1968	947	2.00739	1,901	826	18	735	1,923	2,658	894
1969	876	2.04909	1,795	1,047	17	898	1,722	2,620	1,099
1970	810	2.10741	1,707	1,497	79	1,161	1,936	3,097	1,127
1971	821	2.16809	1,780	2,509	97	1,486	2,420	3,906	1,413
1972	769	2.10793	1,621	3,099	91	1,979	2,502	4,481	1,561
1973	812	1.94951	1,583	2,994	129	1,742	2,538	4,280	1,729
1974	822	2.32847	1,914	2,712	160	1,761	2,679	4,440	1,755
1975	838	2.39976	2,011	3,689	142	2,574	2,747	5,321	1,992
1976	627	1.66667	1,045	4,489	76	3,393	2,286	5,679	1,771
1977	650	2.40769	1,565	5,696	215	4,294	2,519	6,813	2,004
1978	562	3.10676	1,746	7,549	164	6,489	2,286	8,775	2,360
1979	441	2.76190	1,218	6,613	326	5,991	2,314	8,305	1,560
1980	418	2.63158	1,100	7,218	339	6,224	1,942	8,166	1,373
1981	434	2.59217	1,125	9,385	1,559	7,081	2,082	9,163	1,161
1982	398	2.53518	1,009	9,657	449	8,612	1,774	10,386	992

Table A.14. Eastern Europe supply/utilization feed grains (1000 MT)

YEAR	AREA HRVST (1000HA)	YIELD (MT/HA)	PRODN	IMPORT	EXPORT	FEED USE	FOOD USE	TOTAL CONSN	END STOCK
1960	23,059	1.86261	42,950	1,905	1,391	28,715	14,893	43,608	1,290
1961	22,340	1.79212	40,036	2,653	1,552	25,430	15,377	40,807	1,620
1962	21,372	1.82323	38,966	3,208	1,394	27,906	12,942	40,848	1,552
1963	21,290	1.90968	40,657	3,467	1,842	29,485	12,899	42,384	1,450
1964	21,007	2.01500	42,329	3,294	1,285	31,163	13,147	44,310	1,478
1965	20,740	2.02599	42,019	2,726	1,144	29,725	13,818	43,543	1,536
1966	20,631	2.28976	47,240	2,124	1,785	34,050	13,528	47,578	1,537
1967	20,320	2.26378	46,000	2,335	1,849	33,742	12,692	46,434	1,589
1968	20,168	2.30975	46,583	2,498	1,707	34,462	12,405	46,867	2,096
1969	20,237	2.48668	50,323	2,842	1,786	37,455	13,352	50,807	2,668
1970	19,144	2.28656	43,774	4,387	1,211	36,091	12,051	48,142	1,476
1971	19,537	2.65179	51,808	5,082	994	41,193	14,395	55,588	1,784
1972	19,619	2.89169	56,732	4,516	1,974	43,720	15,569	59,289	1,769
1973	19,217	2.90035	55,736	5,098	2,758	44,568	13,509	58,077	1,768
1974	18,796	3.04357	57,207	5,801	1,033	49,795	12,461	62,256	1,487
1975	19,622	3.02706	59,397	7,742	2,386	50,692	13,275	63,967	2,273
1976	19,334	3.07774	59,505	8,574	1,464	50,356	15,180	65,536	3,352
1977	19,463	3.04686	59,301	8,281	1,451	51,433	14,763	66,196	3,287
1978	18,929	3.19388	60,457	11,416	1,193	54,556	16,034	70,590	3,377
1979	19,775	3.20774	63,433	10,585	1,785	57,982	14,310	72,292	3,318
1980	19,232	3.19187	61,386	11,803	2,041	57,931	13,722	71,653	2,813
1981	19,725	3.27229	64,546	7,000	2,148	55,905	13,710	69,615	2,596
1982	19,366	3.71197	71,886	4,064	3,266	56,756	14,990	71,746	3,534